ER/WM&I DDT

Source/Driver: (Name & Number from ISP, IAG milestone, Mgmt. Action, Corres. Control, etc.)	Closure #: (Outgoing Correspondence Control #, if applicable)	9/10/97 Due Date

S. Paris/M. C. Broussard — Originator Name

G. D. DiGregorio — QA Approval

for A. M. Tyson — Contractor Manager(s)

Ann K. Sieben — Kaiser-Hill Program Manager(s)

T. G. Hedahl — Kaiser-Hill Director

Document Subject:

TRANSMITTAL OF THE DRAFT SAMPLING AND ANALYSIS PLAN AND THE 903 DRUM STORAGE AREA, 903 LIP AREA, AND NON-IHSS AREAS DATA SUMMARY - AMT-100-97

KH-00003NS1A September 3, 1997

Discussion and/or Comments:

Please find attached one copy of the "DRAFT" Sampling and Analysis Plan (SAP) and the 903 Drum Storage Area, 903 Lip Area, and Non-IHSS Areas Data Summary. The Data Summary Report summarizes data useability in support of future 903 Pad Area remediation and is included to support your review of the SAP. It is requested that you provide comments on the SAP by close of business on Wednesday, September 10. Per your instructions, one additional copy of these documents are being delivered directly to DOE for concurrent review.

If you have any questions regarding these documents, please contact Annette Primrose at extension 4385 or Steve Parris at extension 3656 of my staff.

Attachments:
As Stated

cc:
M. C. Broussard
N. Castaneda
A. C. Crawford
S. M. Paris
A. L. Primrose
A. M. Tyson
RMRS Records (2)

Reviewed for Classification/UCNI/OUO
By: Janet Nesheim, Derivative Classifier
DOE, EMCBC
Date: 10-28-08
Confirmed Unclassified, Not UCNI/Not OUO

ADMIN RECORD
A-OU02-001552

"DRAFT"
SAMPLING AND ANALYSIS PLAN
FOR THE
SITE CHARACTERIZATION
AT THE
903 DRUM STORAGE AREA (IHSS 112), 903 LIP AREA (IHSS 155), AND NON-IHSS AREAS

Rocky Mountain Remediation Services, L.L.C

September 3, 1997

Revision No. 0
Document Control No: RF/RMRS-07-_____

TABLE OF CONTENTS

LIST OF ACRONYMS

APO	Analytical Projects Office
ALF	Action Level Framework
bgs	Below Ground Surface
CDH	Colorado Department of Health
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cm	Centimeters
DOE	Department of Energy
DNAPL	Dense Non-Aqueous Phase Liquid
DQO	Data Quality Objective
EA	Exposure Area
EMD	Environmental Management Department
EPA	Environmental Protection Agency
ERM	Environmental Restoration Management
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FO	Field Operations
FOV	Field Of View
GT	Geotechnical
GPS	Global Positioning System
IDM	Investigative Derived Material
in	Inches
IHSS	Individual Hazardous Substance Site
K-H	Kaiser-Hill
LDR	Land Disposal Restriction
m	Meters
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
OU	Operable Unit
OVM	Organic Vapor Meter
pCi/g	Picocuries Per Gram
ppb	Parts per Billion
ppm	Parts per Million
PAH	Polyaromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PID	Photoionization Detector
QAPD	Quality Assurance Project Description
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RF	Rocky Flats
RFI/RI	Resource Conservation and Recovery Act Facilities Investigation/ Comprehensive Environmental Response, Compensation and Liability Act Remedial Investigation
RFCA	Rocky Flats Cleanup Agreement
RFEDS	Rocky Flats Environmental Database System
RFETS	Rocky Flats Environmental Technology site
RMRS	Rocky Mountain Remediation Services
ROD	Record of Decision
ROI	Radiological Operations Instructions
RPD	Relative Percent Difference
RPT	Radiological Protection Technician

SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TCLP	Toxicity Characteristic Leaching Procedure
UCL	Upper Confidence Limit
ug/L	Micrograms per Liter
VOC	Volatile Organic Compound

STANDARD OPERATING PROCEDURES

NUMBER	PROCEDURE TITLE
5-21000-OPS-FO.3	Field Decontamination Procedures
4-S02-ENV-OPS-FO.04	Decontamination of Equipment at Decontamination Facilities
5-21000-OPS-FO.6	Handling of Personal Protective Equipment
5-21000-OPS-FO.7	Handling of Decontaminated Water and Waste Water
4-K56-ENV-OPS-FO.08	Handling and Containerizing Drilling Fluids and Cuttings
4-K55-ENV-OPS-FO.10	Receiving, Marking and Labeling Environmental Containers
5-21000-OPS-FO.11	Field Communications
5-21000-OPS-FO.12	Decontamination Facility Operations
4-B29-ER-OPS-FO.14	Field Data Management
5-21000-OPS-FO.13	Containerization, Preserving , Handling , and Shipping Soil and Water Samples
5-21000-OPS-FO.16	Field Radiological Measurements
4-F99-ENV-OPS-FO.23	Management of Soil and Sediment Investigative Derived Materials (IDM)
4-B11-ER-OPS-FO.25	Shipment of Radioactive Samples
5-21000-OPS-GT.01	Logging Alluvial and Bedrock Material
5-21000-OPS-GT.02	Drilling and Sampling Using Hollow-Stem Auger Techniques
5-21000-OPS-GT.05	Plugging and Abandoning Boreholes
4-E42-ER-OPS-GT.08	Surface Soil Sampling
5-21000-OPS-GT.10	Borehole Clearing
5-21000-OPS-GT.25	Approval Process for Construction Activities on or Near Individual Hazardous Substance Sites (IHSSs)
4-S64-ER-GT.39	Push Subsurface Soil Sample
4-61100-REP-1401	Operation of Gamma Ray Spectroscopy Systems
4-R29-REP-1402	Routine Characterization of HPGe Detectors
4-H58-ROI-06.6	Use of Bicron FIDLER
1-50000-ADM-12.01	Control of Measuring and Test Equipment
3-21000-ADM-17.01	Quality Assurance Records Requirements
2-G32-ER-ADM-08.02	Evaluation of ERM Data for Usability in Final Reports

1.0 INTRODUCTION

The purpose of this sampling and analysis plan (SAP) is to identify and delineate the spatial and vertical extent of soils exceeding the Rocky Flats Environmental Technology Site (RFETS) Cleanup Agreement (RFCA) Action Level Framework (ALF) Soil Tier I Action Levels at the Individual Hazardous Substance Site (IHSS) 112 - 903 Drum Storage Site (903 Pad), IHSS 155 -903 Lip Area (Lip Area) and surrounding Non-IHSS surface soils. Implementation of this SAP will provide better definition of the extent of contamination at the site and delineate the volume of soils requiring remediation. Figure 1.1 provides the locations of the IHSSs and the surrounding area. The overall goal of this sampling program is to determine the location, area, and volume of soils requiring remediation.

Previous investigations have been conducted in these areas to determine the extent of contamination, specifically the OU2 Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation/Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Remedial Investigation (RFI/RI) (DOE, 1995). However, previous surface soil investigations were designed and implemented to characterize exposure areas (EAs) of 2.5- and 10-acres. Because these EAs are considered too large for a remedial alternative evaluation (i.e. the extent needs to be refined), this SAP targets characterizing surface soil contamination with a EA of 1,217 ft^2 (113 m^2 or 2.8 x 10^{-2} acre).

Previous investigations into organic contamination at the 903 Pad have not detected volatile organic compound (VOC) concentrations in subsurface soils above RFCA Tier I action levels; however, evaluation of groundwater data collected at and downgradient of the 903 Pad indicate the presence of a dense non-aqueous phase liquid (DNAPL) source. This suggests that a DNAPL source is present in the area but has not been detected during previous investigations. As a result this SAP targets areas known to have high concentrations of VOCs in groundwater.

In 1996 the Actinide Migration Expert Panel was formed to review existing data on actinide migration at RFETS and make recommendations for future work. Their recommendations included activities to:

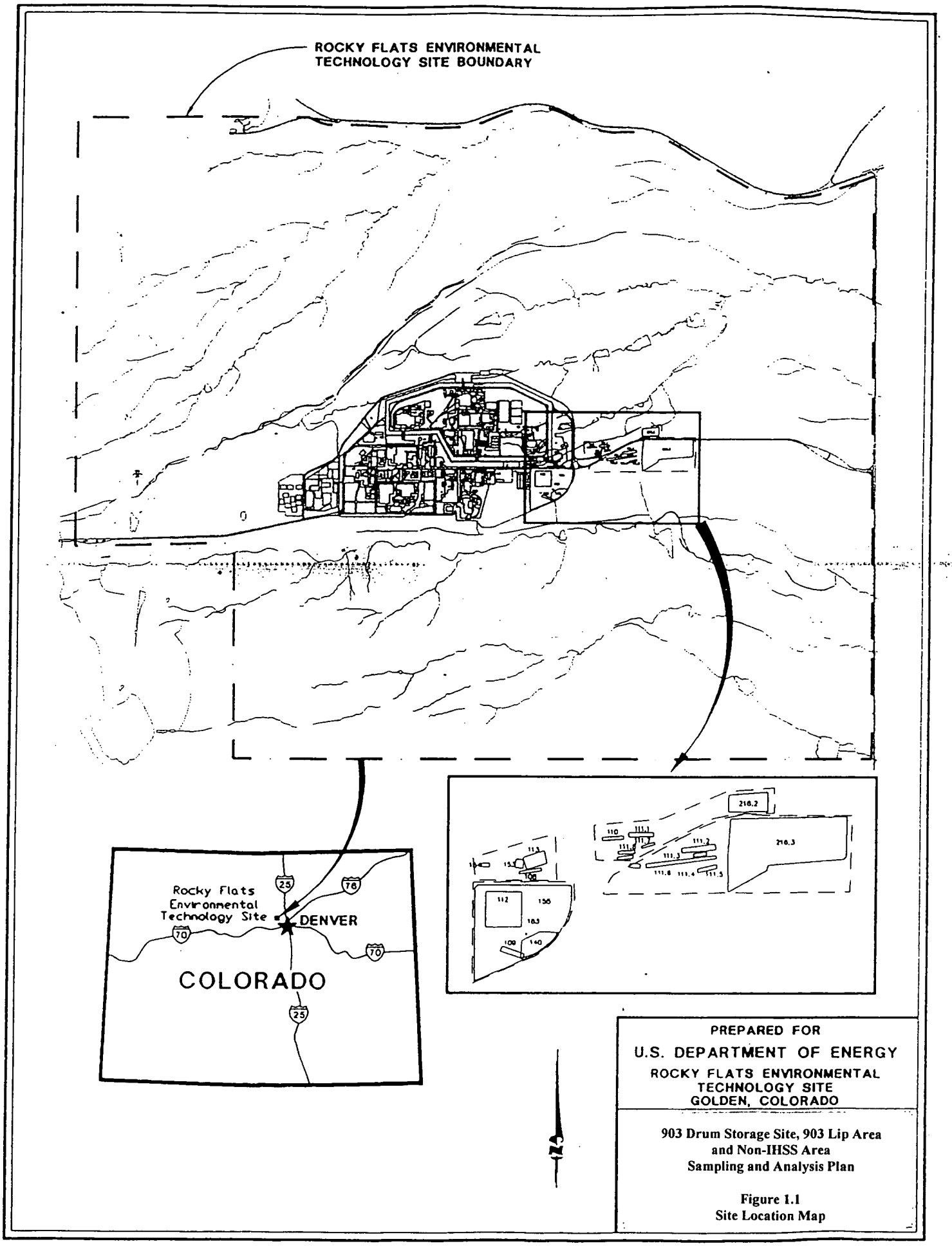
1. Develop a conceptual model for actinide transport, based on a thorough understanding of chemical and physical processes;
2. Investigate the long-term impacts of actinide geochemistry mobility on remedial requirements; and
3. Evaluate the protectiveness of the RFCA soil action levels to surface water quality.

Based on the results of Actinide Migration Expert Panels evaluation, revisions to this SAP may be warranted.

1.1 Background

Releases at the 903 Drum Storage Site (IHSS 112) are considered the primary source of radiological contamination in the surficial soil in this part of RFETS. Drums that contained radioactively-contaminated oils and volatile organic compounds (VOCs) were stored at this location from the summer of 1958 to January 1967. Approximately three fourths of the drums contained plutonium-contaminated liquids while most of the remaining drums contained uranium-contaminated liquids. Of the drums containing plutonium, the liquid was primarily lathe coolant and carbon tetrachloride in varying proportions. Also stored in the drums were hydraulic oils, vacuum pump oils, trichloroethene, percloroethylene, silicone oils, and acetone still bottoms (DOE, 1995).

Leaking drums were noted in 1964 during routine handling operations. The contents of the leaking drums were transferred to new drums, and the area was fenced to restrict access. When cleanup operations began in 1967, a total of 5,237 drums were at the drum storage site. Approximately 420 drums leaked to some degree. Of these, an estimated 50 drums leaked their entire contents. The total amount of leaked material was estimated at around 5,000 gallons of contaminated liquid containing approximately 86 grams of plutonium (DOE, 1995).


ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE BOUNDARY
Rocky Flats
Environmental
Technology Site
DENVER
COLORADO
25
76
70
70
25
216.2
216.3
110
111
111.2
111.3
111.8
111.4
111.5
112
156
163
109
140
PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE
GOLDEN, COLORADO
903 Drum Storage Site, 903 Lip Area
and Non-IHSS Area
Sampling and Analysis Plan
Figure 1.1
Site Location Map

From 1968 through 1970, some of the radiologically contaminated material was removed, the surrounding area was regraded, and much of the area was covered by clean road base and an asphalt cap. However, during drum removal and cleanup activities, wind and rain spread plutonium to the east and southeast from the 903 Pad area resulting in IHSS 155 (903 Pad Lip Area). Several limited excavations have removed some of the plutonium contaminated soils from the Lip Area (DOE, 1995). However, results from the OU2 Phase II RFI/RI sampling and analysis confirm that radiologically contaminated soils remain. Surface soils to the east and southeast of the Lip Area also exhibit elevated plutonium-239/240 and americium-241activities. This contamination is primarily attributed to wind dispersion from the 903 Pad with a potential contribution from historical fires and stack effluent.

1.2 Existing Data

Numerous investigations to assess the extent of contamination at the 903 Pad, Lip Area, and Non-IHSS areas have been conducted. These investigations are described in the 903 Drum Storage Site, 903 Lip Area, and Non-IHSS Areas Data Summary (RMRS, 1997) and briefly described below.

1.2.1 Surface Soils

HPGe Surveys - HPGe surveys conducted in 1990 (EG&G, 1991) and 1994 (RMRS, 1996) provide useful information on the activity of americium-241 in surface soils over the Non-IHSS study area. These data were collected on a 150 foot grid to accommodate the HPGe detector's field of view (FOV) of 150 feet. The surveys were not conducted over the 903 Pad and Lip Area and soil samples were not collected to supplement the surveys. The results from these surveys are being utilized to define the boundaries of this characterization activity.

Surface Soil Radiological Data - Surface soil samples were collected in support of the OU2 Phase II RFI/RI (DOE, 1995). As detailed in the RFI/RI, samples were collected utilizing two sampling methods; the CDH sampling method and the RF sampling method. Surface soil sample results were compared with RFCA Tier I surface soil action levels. The results of the comparison indicated that samples collected from five 2.5-acre plots exceed the Tier I action levels. These plots include two 2.5-acre plots (Plots 28 and 34) sampled using the CDH sampling method and three 2.5-acre plots (Plots 29, 36, and 46) sampled using the RF method (RMRS, 1997).

1.2.2 Subsurface Soils

Subsurface Soil Radiological Data - Three data sources were evaluated to determine the depth of radiological contamination with in the study area: 1) RFI/RI borehole data (DOE, 1995); 2) RFI/RI soil profile pits (DOE, 1995); and 3) samples collected in support of a 1980 soil decontamination project (Rutherford, 1981). Results from the borehole samples were compared to RFCA action levels revealed that no samples exceed the Tier I soil action levels for radiological contaminants. However, samples collected from soil profile pit TR08 exceeded Tier I action levels to a depth of 27 centimeters (cm) (10.6 inches[in]). Soil profile pits were sampled at 3 cm (1.2 in) intervals to a total depth of 1 meter (m) (3.28 feet). Samples collected at soil profile pit TR06, located adjacent to pit TR08, were not analyzed because activities exceeded the DOT shipping requirements. It is assumed that radiochemical results from pit TR06 would also exceed Tier I action levels, if analyzed.

Soil samples collected beneath the 903 Pad in support of the 1980 soil decontamination project exceeded Tier I action levels to a depth of 66 cm (26 inches). However, no RFI/RI soil borings detected radiological contamination in excess of Tier I action levels. As a result, a discrepancy with the depth of radiological contamination between these investigations exists.

Subsurface Soil VOC Data - Three sources of data were evaluated to determine the nature and extent of contamination at the 903 Pad: 1) RFI/RI borehole data (DOE, 1995); 2) IM/IRA soil gas survey results (DOE, 1994); and 3) groundwater monitoring well data.

Borehole sample results from the RFI/RI were compared with RFCA Tier I soil action levels revealed that no samples exceeded action levels for organic contaminants. The soil gas survey indicated that the highest VOC concentrations were located immediately south of the southeast corner of the 903 Pad. Tetrachloroethene was detected at 27,000 ug/L at a depth of 5 feet. However, at adjacent soil gas locations and boreholes, tetrachloroethene is either not detected or detected at very low concentrations. Soil gas concentrations for the remaining portion of the 903 Pad ranged from 0 -500 ug/L with the highest concentrations around boreholes 08691 and 08891.

1.2.3 Groundwater

Because of the complex nature of DNAPL transport and fate, DNAPL may often be undetected by direct methods leading to incomplete site assessments and inadequate remedial designs (EPA, 1992). A guide for estimating the potential for a DNAPL source at a site includes assessing if concentrations of DNAPL-related chemicals in groundwater are greater than 1% of the pure phase solubility of the DNAPL compound (EPA, 1992).

A VOC-contaminated groundwater plume extends from the 903 Pad area to the east. The highest concentrations are found in groundwater samples collected from wells 06691 and 08891 located on the asphalt portion of the 903 Pad. Concentrations of contaminants in groundwater drop rapidly moving eastward from the 903 Pad area. The primary groundwater contaminant in well 06691 is carbon tetrachloride with concentrations ranging from 51 to 100,000 parts per billion (ppb). Methylene chloride (150 to 35,000 ppb) and chloroform (92 to 49,000 ppb) are also observed. Groundwater sample results for well 08891 indicate the primary contaminant as tetrachloroethene at concentrations ranging from 470 to 20,000 ppb, along with carbon tetrachloride (290 to 17,000 ppb), cis-1,2,dichloroethene (94 to 2,900 ppb) and trichloroethene (210 to 4,600 ppb). The next highest concentration of carbon tetrachloride in groundwater is found in samples collected from well 13191, which is located west of the well 06691 and off the western edge of the 903 Pad. At this location, observed carbon tetrachloride levels ranged from 122 to 4,800 ppb.

Table 1.1 provides a comparison of the pure phase aqueous solubility and concentrations of DNAPL-compounds detected in groundwater at or near the 903 Pad. The comparison indicates that tetrachloroethene and carbon tetrachloride have been detected in groundwater samples at 10% and 12% of their aqueous solubility's, respectively. Based on the results of this comparison and known historical site uses, there is a high potential of pure phase organic contaminants at the 903 Pad site.

Radionuclide contamination in groundwater was investigated by reviewing groundwater monitoring well sample results from 1991 to 1995 in wells identified as containing VOC contamination as discussed above. Groundwater analytical data indicate that one well, 09091, located on the 903 Pad, contains americium-241 and plutonium-239/240 activity in excess of Tier I action level for groundwater. Tier I action levels for americium-241 and plutonium-239/240 are 14.5 pCi/L and 15.1 pCi/L , respectively. This well has produced groundwater samples with maximum activities of 354.6 pCi/L of americium-241and 46.54 pCi/L of plutonium-239/240. Uranium-isotopes have not detected in excess of their respective background activity in groundwater samples collected over this period.

TABLE 1.1 COMPARISON OF PURE PHASE AQUEOUS SOLUBILITY WITH CONCENTRATIONS IN GROUNDWATER SAMPLES - SELECTED VOCs

COMPOUND	PURE PHASE AQUEOUS SOLUBILITY AT 25°C (mg/L)	HIGHEST CONCENTRATION DETECTED IN GROUNDWATER (mg/L)	RATIO GROUNDWATER /AQUEOUS SOLUBILITY (%)
Carbon Tetrachloride	793	100.0	12.6
Chloroform	7,920	49.0	0.62
cis-1,2,dichloroethene	3,500	2.9	0.83
Methylene Chloride	13,000	35.0	0.27
Tetrachloroethene (PCE)	200	20.0	10.0
Trichloroethene (TCE)	1,100	4.6	0.42

1 EPA, 1996. Soil Screening Guidance: Technical Background Document

1.3 Site Conceptual Model

The surficial geology in the study area consists of Quaternary alluvium, colluvium and slump deposits along with artificial fill, soil and debris deposits, and disturbed soil. The surficial deposits overlie bedrock which consists of weathered claystone and minor bedrock sandstones of the Cretaceous Arapahoe and Laramie Formations. Surficial deposits consist of sandy clay and clayey gravel. Soil developed over the alluvium is rocky and sandy in contrast to the clayey soils developed over the claystone bedrock.

Artificial fill is present directly beneath the 903 Pad and in the Lip Area as a result of previous remediation activities. In November 1968 "slightly contaminated" soil were graded from outside the fence at the 903 Pad into the fenced area to be capped. In September of 1969 a base course material overlay, soil sterilant, and asphalt primer were constructed for the 903 "containment barrier" (Pad). The asphalt pad was constructed in October of 1969 and is reportedly to be 3 in (7.6 cm) thick. The thickness of the base coarse materials beneath the 903 Pad is assumed to be approximately 8 inches (20 cm) . In February 1970, operations were initiated to apply additional fill (base course) over the Lip Area due to soil contamination.

Barker (1982) removed 4,000 cubic feet of contaminated soils in 1976 down slope of the Lip Area and covered the area with clean topsoil and reseeded. In 1978, 43,000 square feet of surface soils were removed down slope of the Lip Area to a depth of approximately 1.4 in (3.5 cm). The area was "backfilled and revegated". This states that surface soils down slope of the Lip Area are imported fill material and radiological contaminated soils may be present in this area at depth. Logs from the Soil Profile Pits TR-06, TR-07 and TR-08, excavated in the Lip Area in support of the OU2 Phase II RFI/RI, indicate a fill thickness of 0.8 (2 cm), 0.8, and 5.1 in (13 cm) respectively.

The surficial soil contaminants of concern are plutonium-239/240 and americium-241. Plutonium-239/240 is relatively insoluble and tends to be strongly sorb to fine grained soil particles. While there is a tendency for plutonium-239/240 and americium-241 activities to decrease with increasing distance from the source areas, several areas outside of the 903 Pad and Lip Area show higher activities. This distribution is not typical of wind disbursement and reflects other factors including surface water run-off and/or drum storage outside the Lip Area. The OU2 RFI/RI (DOE, 1995) states that 90% of the americium-241 and plutonium-239/240 activities are concentrated in the upper 6 in (15 cm) of the soil.

Subsurface soil contaminants of concern include carbon tetrachloride, tetrachloroethene, trichloroethene, americium-241 and plutonium-239/240. Organic contaminant concentrations detected in groundwater indicate that a free phase DNAPL may be present beneath the 903 Pad area. The exact location of the DNAPL has not

been identified from previous investigations including boreholes and soil gas vapor studies. It is unknown if the free phase DNAPL has remained in the soil pore space as residual contamination or is present as a free-phase liquid on the bedrock surface.

Figure 1.2 provides two conceptual models of the 903 Pad Site. The first model presents the conservative scenario with the DNAPL primarily residing in the residual phase captured by capillary pressures with little DNAPL reaching the groundwater table. The second model presents the worst case scenario with a complex DNAPL pathway in both the vadose and saturated zones and with a pooled mobile DNAPL phase resting on bedrock. A condition somewhere between these two extremes likely exists at the site.

2.0 DATA QUALITY OBJECTIVES

The data quality objective process consists of seven distinct steps and is designed to be iterative; the outputs of one step may influence prior steps and cause them to be refined. Each of the seven steps are described below.

2.1 State the Problem

Surface Soils

Previous investigations at the 903 Pad site have revealed radiological contamination in surface soils exceeding RFCA Tier I action levels triggering an action. The exposure area (EA) of previous investigations were 2.5- and 10-acre plots. Remedial alternatives options being explored for the site include; 1) excavation of contaminated soils and offsite disposal; and 2) excavation of contaminated soils, relocation, and covering with a engineered cap. Based on these alternatives, evaluation of a smaller EA is required to delineate and exclude soils not exceeding Tier I action levels therefore minimizing the area of soil requiring remediation.

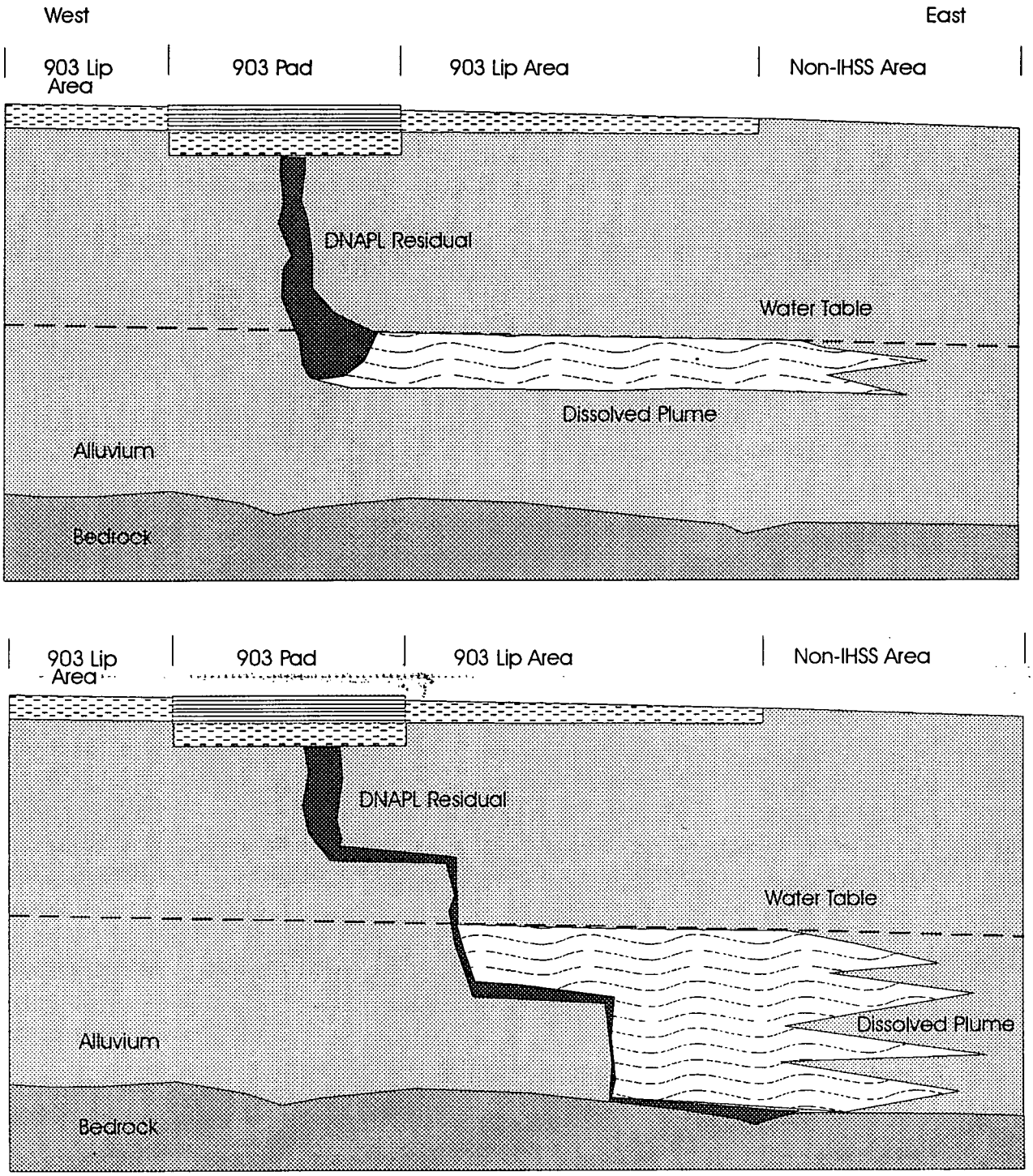
Asphalt

Remediation of subsurface soils at the 903 Pad will require the removal and disposal of the asphalt comprising the 903 Pad. Low-level waste disposal facilities require that waste be characterized adequately to ensure that sample results represent the waste with at a 90% confidence level. No data, with the exception of a 903 Pad surface gamma survey (Rutherford, 1981), currently exists for the asphalt. Preliminary analytical data will be required to design a statistically-based sampling plan to meet the waste acceptance criteria of waste disposal facilities qualified to accept the waste

Subsurface Soils

VOC Contamination - An analysis of groundwater data from the 903 Pad area indicates that DNAPL may be present in subsurface soils at the 903 Pad. Existing VOC data collected from boreholes were compared to Tier I action levels and the results of the comparison indicate that no soil sample exceeds Tier I action levels. However, groundwater data indicate the potential for free-phase DNAPL. Additional information is required to determine the location and depth of residual and/or free phase VOC contamination for remedial alternative selection.

Radionuclide Contamination - Historical data from the 903 Pad indicate radionuclide activities above background in soils to 26 inches (66 cm) below the top of asphalt pad. A review of OU2 RFI/RI borehole data



Legend

Base Coarse Fill

Asphalt

Figure 1.2
903 Pad sampling and Analysis Plan
Site Conceptual Models Presented
As Two Series for DNAPL in Groundwater

reveal no soil samples exceeded the Tier I action levels. However, radionuclides are suspected to have been transported with the solvents released at the site. Additional data is needed to determine the depth of radiological contamination for RFCA action level comparison. In addition, an evaluation of OU2 Phase II RFI/RI surface soil data indicated 5 Plots, each with an area from 2.5-acres which exceeded the RFCA Tier I action levels (RMRS, 1997). The soil samples used for the evaluation were collected to 0.64 and 2.0 inches in depth using the CDH and RF sampling methods, respectively. However, the depth of contamination has not been adequately characterized in these plots. These data are required to determine the depth of excavation of soils if excavation and disposal is the selected alternative for remediation.

Lastly, surface soils in the Lip Area have been disturbed by historical activities associated with stabilization of radiological contamination at the 903 Drum Storage Site. In 1969, contaminated surface soils in the Lip Area were graded into the 903 Drum Storage Site prior to covering the soils with an asphalt cap. Subsequent to grading the Lip Area, the surface was covered in 1970 with an imported base coarse material to prevent wind erosion and transport of contaminated soils from the Lip Area. Contaminated soils may exist below the import material even though the OU2 Phase II RFI/RI surface soil sampling programs did not detect plots exceeding Tier I action levels in this area. These conditions may also exist in areas where remediation of surface soils was conducted in 1976 and 1978.

2.2 Identify the Decision

Soils

Decisions required to be made include:

- Where do concentrations/activities of contaminants/radionuclides in soils exceed RFCA Tier I Action Levels, and if they do to what spatial and vertical extent?
- Is VOC contamination present beneath the 903 Pad at levels exceeding Tier I action levels, and if it is where is it located?

Actions based on the decisions include the remediation of soils identified as exceeding Tier I action levels or subsequent remedial actions/no further action to be determined in the Buffer Zone OU ROD.

Asphalt

Decisions to be made on the asphalt are based on the identification of the waste as low-level, mixed, or hazardous, and to determine if the characterization data is sufficient to design a future sampling and analysis plan to meet the 90% confidence level requirement of waste disposal facilities' WACs.

2.3 Identify Inputs to the Decision

Soils

Inputs into the decision include radioanalytical and chemical results from surface and subsurface soil samples for RFCA Tier I action level comparison. These inputs can be used to determine characterization information.

Information to be determined from the additional investigation includes:

- The extent of organic contamination above Tier I action levels at the 903 Pad;
- The extent of radiological contamination above Tier I action levels beneath the 903 Pad;
- The extent of radiological contamination in natural soils underlying basecoarse fill material of the Lip Area, and natural soils in the 1976 and 1978 remediation areas;

- The extent of radiological contamination in natural soils in the Non-IHSS area west of the 903 Pad and Lip Area.

Asphalt

Inputs to the decision include waste characterization data, sufficient data to perform RCRA Toxicity Characteristic Leaching Procedure (TCLP) and land disposal restrictions (LDR) comparisons, and a background activity comparison. Decision rules will include:

- If asphalt exceeds background activity for radionuclides it will be considered low level waste;
- If the asphalt exceeds TCLP contaminant thresholds (for compounds known to be disposed at the site) it will be managed according to RCRA requirements.
- If the asphalt exceeds LDRs (for compounds known to be disposed at the site) it will require treatment prior to disposal.

Asphalt inherently contains polyaromatic hydrocarbon (PAH) compounds which could cause the material to fail the TCLP. Therefore, only the results of compounds know to have been disposed of at the site will be evaluated to determine if the material is a hazardous waste.

2.4 Define the Study Boundaries

Surface Soils

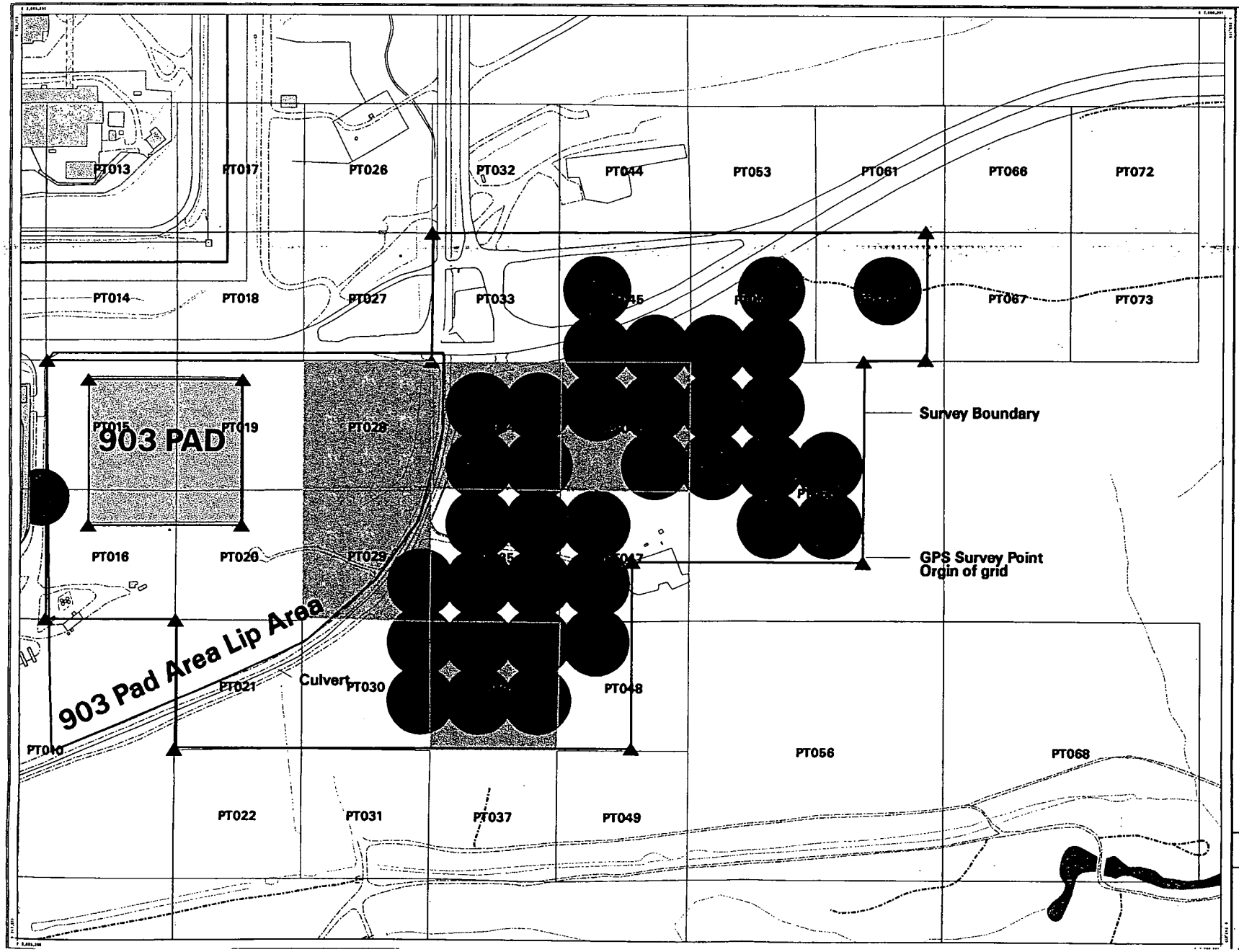
The study area has been selected from previous HPGe surveys and surface soil surveys, and includes surface soils in areas which have americium-241 activities in excess of 10 pCi/g. This study area includes five 2.5-acre surface soil plots which were identified as exceeding Tier I Action Levels for radionuclides through the data evaluation of the OU2 Phase II RFI/RI data. The study area also includes the 903 Pad, the Lip Area, and areas where previous surface soil remediation actions were performed in 1976, and 1978. Figure 2.1 shows the study area.

Asphalt Pad

The study boundaries include the entire 3.4-acre area of the asphalt pad

Subsurface Soils

VOC Contamination - The study area has been determined to include an area of the 903 Pad where soils have historically shown staining and where high concentrations of VOC contamination exist in groundwater . When spilled on the ground surface and once the residual saturation value of soils is exceeded, the DNAPL will move vertically in the vadose zone under the influence of gravity. The DNAPL will continue its migration downward though the saturated zone where sufficient product is present to displace water in the pore. Once the DNAPL reaches the aquatard, bedrock claystone at the 903 Pad site, it can potentially migrate laterally, even in the absence of a hydraulic gradient on the water table. The depth to which the suspected DNAPL has penetrated is currently unknown.



Rocky Flats Surface Soil Sampling Plot Locations Around the 903 Pad

Figure 2-1
Study Area

Explanation

- HPGe 150 foot FOV Circles (above 10pCi/g Am-241)
- Plots above Tier I Action Levels
- Proposed GPS Survey Point
- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads

DATA SOURCES

DISCLAIMER

Scale = 1 : 2760
1 inch represents 230 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

RMRS Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

2.5 Develop a Decision Rule

Soils

The parameters of interest include the activity/concentrations of the following radionuclides/contaminants in surface and subsurface soils:

- Plutonium-239/240;
- Americium-241;
- Uranium-234;
- Uranium-235;
- Uranium-238; and
- VOCs (subsurface soils only).

Radionuclides - The decision level is based on activity of radionuclides in soils as defined in RFCA Tier I Soil action levels (DOE, 1996). If a mixture of radionuclide contaminants a, b, c are present in the soil with activities a_a, a_b, and a_c and if the applicable action level of radionuclide in soil, as stated in RFCA, is A_a, A_b, and A_c respectively, then the activity in the soil shall be limited so that the following relationship exists:

$$\frac{a_a}{A_a} + \frac{a_b}{A_b} + \frac{a_c}{A_c} \leq 1 \qquad \text{(Eq. 2.1)}$$

If the sum of ratios, as calculated in the above equation 2.1, exceeds 1 an evaluation, remedial action, and/or management action is triggered. Table 2.1 provides the Tier I action levels for radionuclides using the Buffer Zone hypothetical resident scenario.

TABLE 2.1 RFCA ALF TIER I SOIL ACTION LEVELS - RADIONUCLIDES

RADIONUCLIDE	ACTIVITY (pCi/g)
Americium-241	215
Plutonium-239/240	1429
Uranium-234	1738
Uranium-235	135
Uranium-238	586

If individual radionuclide activities in surface or subsurface soils exceed RFCA Tier I Action Levels, or the sum of their respective ratios exceed 1, action is required. If activities or the sum of ratios are below the Tier I action levels the soils will be addressed under the Buffer Zone OU record of decision (ROD).

Volatile Organic Compounds - The decision level is based on concentration of volatile organic compounds in soils as defined in RFCA ALF Subsurface Soil Action Levels. If the concentration of VOCs in soils exceed Tier I action levels for subsurface soils, an action must be taken. Table 2.2 provides the Tier I action levels for VOCs suspected to be present in soils at the 903 Pad.

TABLE 2.2 RFCA ALF TIER I SUBSURFACE SOIL ACTION LEVELS - SELECTED VOCs

COMPOUND	TIER I ACTION LEVEL (mg/kg)
Carbon Tetrachloride	110.00
Chloroform	152.00
1,2,-Dichloroethene (Total)	9.51
Methylene Chloride	5.77
Tetrachloroethene	11.5
Trichloroethene	9.27

Asphalt

The parameters of interest in asphalt samples include the activity/concentrations of the following radionuclides/contaminants:

- Plutonium-239/240;
- Americium-241;
- Uranium-234;
- Uranium-235;
- Uranium-238; and
- TCLP-VOCs.

Radionuclides - Decision levels are based on the presence of RFCA-regulated radionuclides. If radionuclides are present in the asphalt it must be managed as a radioactive waste material.

Volatile Organic Compounds - Decision levels are based on TCLP thresholds. It the concentrations of organics in TCLP results exceed the TCLP thresholds the asphalt will be managed according to the RCRA hazardous waste regulations. It should be noted that asphalt inherently contains PAHs associated with the petroleum-base cement used in the mix. Therefore, this investigations is concerned only with organic compounds known to have been disposed of at the site.

2.6 Specify Limits on Decision Errors

Surface Soils

The HPGe investigation in this SAP was designed to provide 100% coverage of the study area. HPGe survey results will be field verified with the collection and analysis of surface soil samples. Soil samples will be collected to ensure a correlation coefficient of 0.90 with the HPGe results based on linear regression analysis.

Subsurface Soils

903 Pad - The sampling program is based on the placement of 25 boreholes on a central-aligned grid of 80 feet over the 3.4 acre area of the 903 Pad The decision error associated with this grid is there exists a 10% chance of not encountering a 90-foot diameter circular radiological hot spot beneath the Pad.

930 Lip Area - No decision errors are associated with the Lip Area investigation. The subsurface sampling program is designed to characterize the depth of contamination and subsequently the depth of excavation during remedial activities in the Lip Area.

Non-IHSS Area - Like the 903 Pad Lip Area, no decision errors are associated with the Non-IHSS Area investigation. The subsurface sampling program is designed to characterize the depth of contamination and subsequently the depth of excavation during remedial activities.

The QA/QC goals of the project shall include a 1 in 20 frequency for duplicate samples and equipment rinsates, a trip blank provided for each shipment of soils for VOC analysis. Relative percent difference (RPD) goals for soils shall be 40% for radionuclides and 20% for VOCs. A completion goal for the project shall be 90%, that is 90% of the data collected, analyzed, and verified to be of acceptable quality for decision making. Twenty-five percent of the data shall undergo laboratory validation by a third party.

2.7 Optimize the Design for Obtaining Data

Soils

Radiological Investigation - Spatial. This SAP proposes using a linear regression double sampling technique to estimate the mean activity of plutonium-239/240, americium-241, and uranium-234, -235, -238 in surface soils. The double sampling method utilizes the fact that there is a strong linear correlation between americium-241 and plutonium-239/240 in surface soils. It is difficult to measure low levels of plutonium directly in the environment. Direct measurements of small concentrations require laboratory analyses which are not appropriate for a large study area proposed for this investigation.

The HPGe will be used to determine the average americium-241 activity over the FOV of 1,217 ft^2 when the detector is placed 1 meter over the ground surface. The linear relationship between HPGe measurements and americium-241 and plutonium-239/240 activities in soils will be verified by the collection of samples collected using the RF surface soil sampling technique. The soil sample results will be compared with results of the HPGe survey and a linear regression will be performed to estimate activities of RFCA-regulated radionuclides at all HPGe survey locations. These values will be compared to RFCA Tier I action levels and areas exceeding Tier I action levels will be targeted for further investigations including FIDLER surveys to determine if the activity is a result of a hot spot or if the activity is spread over the entire FOV.

A 100 pCi/g activity of americium-241 has been selected as an threshold value for the HPGe survey. This value has been calculated to represent 0.85 of the RFCA sum of ratios. This value was calculated by substituting activities into the sum of ratios equation (eq. 2.1) using the highest activities measured for uranium isotopes in surface soils from the OU2 Phase II RFI/RI (DOE, 1995) and using the americium-241/plutonium239 ratio to estimate plutonium-239/240 activities. The highest activities measured for uranium isotopes from the OU2 Phase II RFI/RI (DOE, 1995) CHD sampling program are: 6.796 pCi/g for uranium-233/234; 2.110 for uranium-235; and 11.94 pCi/g for uranium-238. The americium-241/plutonium-239 ratio of 0.199, calculated from the OU2 Phase II RFI/RI (DOE, 1995) CHD surface soil sampling results, indicates that plutonium activity was 5.024 times that of americium-241. Values incorporated into Equation 2.1 are provided below:

Americuim-241	Plutonium-239	Uranium-233	Uranium-235	Uranium-238	Sum of Ratio

$$\frac{100}{215} + \frac{502.4}{1429} + \frac{6.79}{1738} + \frac{2.110}{135} + \frac{11.94}{586} = 0.85$$

Radiological Investigation - Vertical. Subsurface soil samples will be collected from areas in which surface soils are suspected to exceed Tier I action levels. The depth of contamination is required to calculate volumes of soils requiring remediation. In addition, subsurface soil samples will be collected in areas where previous remedial actions have been performed to determine if the actions removed contaminated soil to below Tier I action levels. Areas requiring further characterization include:

- Surface soils exceeding the Tier I action levels as identified from the HPGe Survey;
- Basecoarse and natural soils beneath the 903 Pad;
- Natural soils underlying basecoarse fill of the Lip Area (1970 remedial action); and
- Soils underlying the areas of previous remedial actions conducted in 1976 and 1978.

The locations and number of samples required to be collected to characterize areas where surface soils exceed Tier I action levels will be determined after the results of the HPGe survey and associated soil samples are evaluated. The SAP will be modified following the analysis of HPGe results.

Twenty-five shallow boreholes are proposed for the characterization of radionuclides beneath the 903 Pad. Twenty-five boreholes over the 3.4-acre 903 Pad represents a borehole completed at each node of a 80 foot by 80 foot square grid. Based on this grid, it is calculated that a 90-foot diameter hot spot or larger has no more that a 10% chance of not being hit.

Fourteen boreholes are proposed to be completed over the Lip Area. A simple systemic design for sampling the Lip Area was selected. The design was selected by the placement of a borehole in each quadrant of a 2.5-acre plot. The grid represents the placement of a borehole at each node of a 165 foot by 165 foot central aligned square grid. This equates to one borehole for each 0.625-acre of the Lip Area. Based on this grid, it is estimated significant variations in soil activity over an area larger than a 185-foot diameter circular area have no more that a 10% chance of not being detected. Additional boreholes are proposed to be completed in the area where surface soils were remediated in 1976 and 1978. One boring will be completed in the 1976 remediation area, and four boring will be completed in the 1978 remediation area. However, the borehole locations are not statistically based.

VOC Investigation - The study is designed to investigate high concentrations of VOCs in groundwater monitoring wells at the 903 Pad, and at soil gas sampling locations at the southeast corner of the 903 Pad. The number and locations of the wells are based on authoritative (judgment) sampling. The concentrations of specific VOCs in the groundwater monitoring wells samples were found to exceed 10% of the aqueous solubility of the compound and is suspected to exist as a DNAPL. The proposed investigation locates boreholes surrounding these groundwater monitoring well.

One VOC investigation site is located at the southeast coroner of the 903 Pad where historical photographs and soil gas surveys indicate a potential VOC release. Soil borings are proposed to be located east of existing Borehole 07191. Soil samples collected from Borehole 07191 did not detect elevated concentrations of VOCs. Soil borings proposed for the VOC investigation will be located directly where high VOC concentrations were detected in soil gas.

Asphalt

Asphalt samples from the 903 Pad will be collected to obtain a preliminary waste characterization profile of the material for disposal purposes. The exact number of samples required to characterize the 903 Pad asphalt with at the 90% confidence level (required by disposal facilities) requires some information on the population. No analytical data exists for the asphalt, and preliminary data is required. Therefore, 9 asphalt samples will be collected from randomly selected locations over the 903 Pad. Sample locations shall be based on the grid spacing developed for the 903 Pad subsurface investigations. Nine sampling locations will be selected during the subsurface investigation for asphalt sample collection which will be submitted to the laboratory for radiochemical and chemical analysis. The results of these samples will be analyzed to determine the number of sample required of the asphalt to obtain a 90% confidence level.

3.0 SAMPLING AND ANALYSES - STRATEGY AND DESIGN

3.1 Radiological Contamination

The spatial and vertical extent of radiological contamination will be assessed within the proposed study area. Spatial extent of contamination will primarily be assessed using a non-intrusive HPGe field method. The HPGe method results will be verified and correlated to radiochemical data by the analysis of surface soil samples collected from selected HPGe measurement locations. The vertical extent of contamination will be assessed utilizing sampling methods employing Geoprobe® or conventional hollow-stem auger drilling techniques.

3.1.1 Surface Soil Investigation

The goal of the spatial investigation is to determine the total inventory (activity) of RFCA-regulated radionuclides above Tier I action levels within the study area. The exposure area has been defined to be the FOV of the HPGe survey of 1,217 ft^2 (2.8×10^{-2} acre). A double sampling technique will be employed to determine the total activity in the EA. Plutonium 239/240 and americium-241 are expected to have a linear relationship and a high coefficient of correlation. Americium-241 activities in surface soils can be determined with less expensive *in situ* methods rather than plutonium-239/240 which requires expensive radiochemical techniques performed in a laboratory. The Compendium of *In Situ* Radiological Methods and Applications at Rocky Flats Plants (EG&G, 1993) provides a detailed discussion on the physics of *in situ* measurement of radionuclides in the environment.

The first phase of the field program will consist of a surface soil HPGe survey using the truck and/or tripod-mounted detectors. When individual HPGe results are interpreted to exceed Tier I action levels a second surface soil survey technique will be employed. A FIDLER survey will be conducted over the HPGe's FOV (exceeding Tier I Action Levels) to determine if the exceedance is a result of an isolated hot spot or if the activity is consistent over the area.

3.1.1.1 Field Preparation

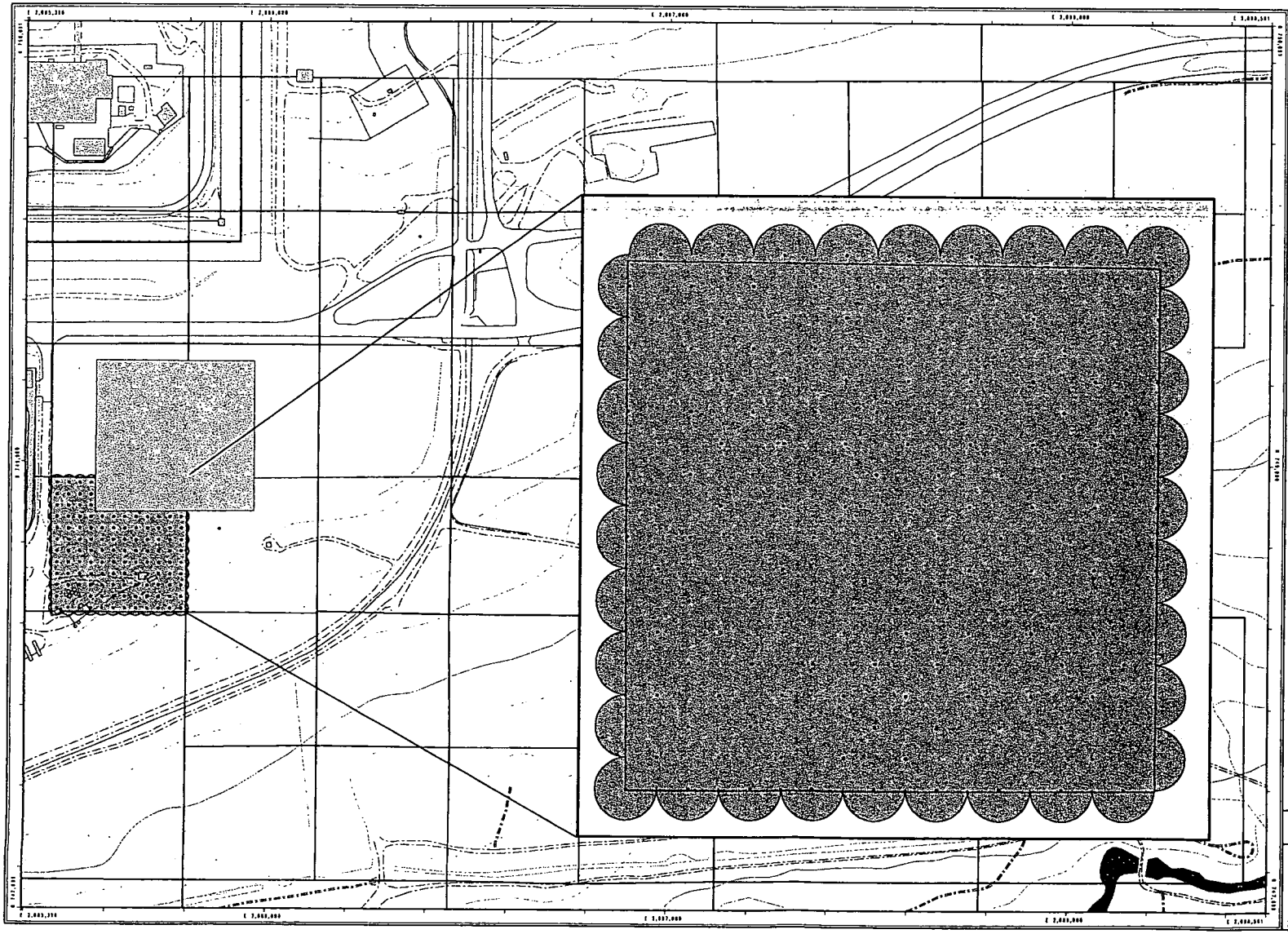
Reference stakes for the HPGe grid will be placed in the field using a Global Positioning System (GPS) before data collection activities are initiated. From these stakes, the HPGe survey grid will be laid out using tape and compass methods, at the spacing specified in Section 3.1.1.2. Each measurement point will be staked, flagged, and numbered for reference by the HPGe crew.

3.1.1.2 HPGe Survey

The HPGe survey will focus on the Lip Area and Non-IHSS Area. Figure 2.1 provides the extent of the study area. The study area includes all surface soils with elevated concentrations of plutonium-239/240 and/or americium-241 identified during the OU 2 RFI/RI including:

- 35 HPGe FOV plots which exhibit elevated americium-241 activities;
- The area directly below the culvert which drains the 903 Pad and Lip Area where sediments are deposited during surface runoff events; and
- The five 2.5-acre plots which surface soils exceed RFCA Tier I action levels.

With a FOV of 1,217 ft^2, a square grid pattern having row and column spacing of 28 feet has been determined to provide 100 percent coverage for the field survey. This grid spacing translates to 144 HPGe measurements for complete coverage of a 2.5-acre area. Figure 3.1 shows the configuration of a typical HPGe survey grid.



903 Pad, Lip Area and Non-IHSS Areas Sampling and Analysis Plan

Figure 3-1 Typical HPGe Survey Grid

EXPLANATION

- Surface Soil Sampling Plot
- HPGe Measurement Field of View
- HPGe Survey Location

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

Scale = 1 : 3020
1 inch represents approximately 252 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
RMRS Rocky Mountain Remediation Services, L.L.C.

MAP ID: 97-0149

August 29, 1997

To obtain of 10 meter FOV, truck- and/or tripod-mounted detectors will be set at a one meter height above ground surface at each sampling point. Measurement count times will be determined in the field to insure a 95% confidence level of the HPGe to determine americum-241activities in soils to 100 pCi/g. Complete coverage of the survey area is estimated to require approximately 2,400 measurements.

HPGe measurements will be made at each survey location in accordance with Radiological Engineering Procedures 4-61100-REP-1401, *Operation of Gamma Ray Spectroscopy Systems*, and 4-R29-REP-1402, *Routine Characterization of HPGe Detectors,* to meet or exceed the specified threshold criteria of 100 pCi/g. For safety and logistical reasons, truck-mounted HPGe measurements will be limited to flat ground in the east and northeast Americium Zone areas. HPGe data from all instruments will be processed and converted to equivalent Pu-239/240 activity units, then plotted to permit preliminary field evaluation of surface soil Pu-239/240 activity trends.

3.1.1.3 FIDLER Surveys

In areas that HPGe measurements exceed the 100 pCi/g americium-241 threshold value, a follow-on FIDLER survey may be conducted. An evaluation of the nature of the exceedances will be conducted to determine if detailed FIDLER surveys are required. If it is determined that a FIDLER survey is needed, a grid with four-foot spacings will be staked in the field. While all available data will be used to determine whether a FIDLER survey is required, it is anticipated that these will only be conducted where there are not continuous, adjacent measurements above 100 pCi/g, americium-241 indicating the potential presence of isolated small areas with elevated actinide soil contamination.

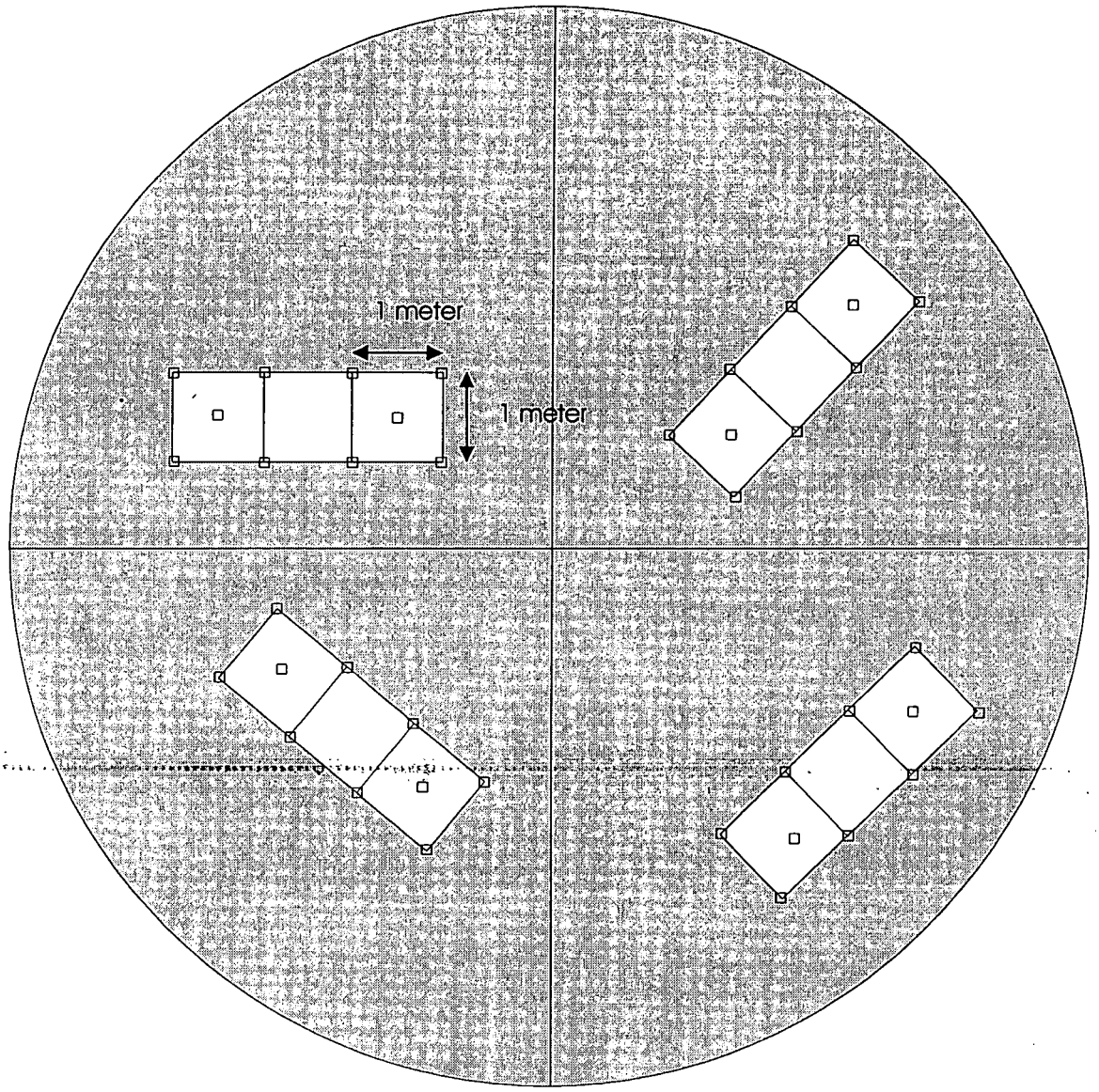
FIDLER surveys will be conducted in accordance with Radiological Operating Instructions (ROI) Manual, 4-H58-ROI-06.6, *Use of Bicron FIDLER.* Readings will be taken and recorded for each of the four-foot grid nodes. When walking between grid nodes, the operators will slowly swing their instruments. If an sharp increase in the reading is seen between grid nodes, the surrounding area will be investigated. All localized areas with higher reading will be flagged as potential hot spots. Potential hot spots and areas of higher concentrations identified during the hand-held FIDLER survey will then be staked, surveyed and labeled for future evaluation.

3.1.1.4 Surface Soil Samples

Surface soil samples will be collected using RF sampling method in an effort to correlate HPGe results to activities in surface soils. The RF sampling method involves the collection of 10 grab samples to depth of 2 inches over a 3 meter area. The grab samples are composited into a single sample and submitted to the laboratory for radiochemical analysis.

The purpose of the soil sampling method is to correlate the HPGe americium-241 measurements with americium-241 and plutonium-239/240 radioanalytical results. Surface soil samples will be collected at a frequency of 1 in 20 (5%) of HPGe measurements until a coefficient of correlation of 0.90 is obtained. If the correlation goal of 0.90 is not reached after the collection of 20 soil samples the sampling strategy will be reevaluated.

The HPGe measurement represents the average surface soil activity over the 1,217 ft^2 FOV. To obtain a replicate soil sample, the area comprising the FOV will be subdivided into four equally-sized quadrants. A RF sample will be collected from each quadrant for a total of four sub-samples per HPGe measurement. The four samples will be composited into a single sample which will represent the physical average of surface soils over the 1,217 ft^2 area. Figure 3.2 provides the typical surface soil sampling scheme for HPGe correlation sampling. The results of the HPGe measurements and soil samples will be utilized to establish the correlation between the



12 meter field of view

Legend

Grab Sample Location

RF Sampling Grid

Figure 3.2
903 Pad & Lip Area
Sampling and Analysis Plan
Typical Surface Soil
Sampling Scheme

two methods to estimate activities at locations where only HPGe measurements are obtained. Table 3.1 provides the estimate number of HPGe measurements and surface soil samples required for the surface soil investigation.

TABLE 3.1 SURFACE SOIL INVESTIGATION - FIELD PROGRAM

AREA	HPGe MEASUREMENTS (Estimated)	SURFACE SOIL SAMPLES[1] (Estimated)
903 Pad	0	0
Lip Areas	650	5
Non-IHSS Area	1750	15

1 Surface soil samples will collected at a frequency of 5% of HPGe readings or until a 0.90 correlation coefficient from linear regression analysis is reached. Not to exceed 20 samples prior to reevaluation.

3.1.1.5 903 Pad Asphalt Samples

Asphalt samples from the 903 Pad will be collected to obtain a preliminary waste characterization data for disposal purposes. Nine asphalt samples will be collected from randomly selected locations over the 903 Pad. Random sampling techniques are appropriate methods for estimating the population mean, determination of total amount of contaminants present and the standard errors of these two estimates. Locations will be determined randomly based on the 903 Pad subsurface soil sampling grid. Table 3.2 provides the analytical program for asphalt samples.

TABLE 3.2 ASPHALT CHARACTERIZATION - ANALYTICAL PROGRAM

ANALYTICAL METHOD	ANALYTES	CONTAINER	PRESERVATIVE	HOLDING TIME
Gamma Spectroscopy	Plutonium-239/240, Americium-241	500-mL wide mouth glass or poly jar	None	6 months
Uranium and Thorium Isotopic	Uranium, Thorium	Combine with Gamma Spectroscopy	None	6 months
SW-846 Method 1311	Volatile Organic Compounds	120-mL capped core, 4 or 8-oz. wide mouth glass jar. Teflon lined closure.	Cool, 4° C	14 days
SW-846 Method 8240B/8260A (Trip Blanks)	Volatile Organic Compounds	3 x 40-mL glass, Teflon lined septa cap.	Cool, 4° C HCl pH<2	14 days

SW-846(EPA, 1986) Test Methods for Evaluation Solid Waste Physical /Chemical Methods

3.1.2 Subsurface Soil Investigation

The depth of radiological contamination is required to calculate the volume of soil requiring remedial action. The depth of radiological contamination will be investigated at:

- VOC investigation boreholes;
- The 903 Pad;
- The Lip Area;
- Non-IHSS Areas where the HPGe has identified surface soils in excess to Tier I action levels; and
- Areas that have undergone previous surface soil remedial actions.

3.12.1 VOC Investigation Boreholes

Samples will be collected utilizing Geoprobe® or conventional hollow-stem auguring techniques. Soil samples will be collected from boreholes completed in support of the VOC investigation and submitted to the laboratory for radiochemical analysis. The radiochemical soil collection interval will be above the interval the VOC sample is collected.

3.1.2.2 903 Pad

Subsurface soil samples will be collected from basecoarse fill material and natural soils beneath the 903 Pad for radiochemical analysis. Soils will be continuously cored and sampled at 6 inch intervals. The samples will be screened for alpha and beta/gamma using a portable field instrument. Boreholes will be advanced a total depth of three feet below the asphalt or one foot past the depth where instrument background levels are reached, whichever is greater. A total of 25 boreholes are proposed for the 903 Pad radiological subsurface soil investigation. Figure 3.3 provides the locations of the proposed boreholes.

3.1.2.3 The Lip Area

Portions of the Lip Area have been disturbed during initial cleanup activities conducted in 1969 prior to the placement of the asphalt cap at the 903 Pad. These activities included the relocation (by grading) of "slightly contaminated" soils from the Lip Area to the 903 Pad for burial under the asphalt cap. The Lip Area was subsequently covered with a basecoarse material to prevent erosion of the remaining soils. Surface soil samples collected in the Lip Area during the OU2 Phase II RFI/RI program may not have encountered, and therefore characterized natural soils.

This sampling program is designed to collect samples of the imported basecoarse fill material and the natural soils underlying the fill material. Portions of Plots 015, 016, 019, 020, 028, and 029 are located within the Lip Area. Each 2.5-acre plot will be divided into four equally sized quadrant representing 0.625-acre each. Portions of the 903 Pad are located in quadrants of Plots 015, 016, 019, 020 which will be characterized under the 903 Pad subsurface program. One soil boring will be placed in each quadrant for a total of fourteen boreholes Samples will be collected utilizing Geoprobe® or conventional hollow-stem auguring techniques. Soils will be continuously cored and sampled at 6 inch intervals. The samples will be screened for alpha and beta/gamma using a portable ratemeter. Boreholes will be advanced a total depth of two feet bgs or one foot past the depth the field instrument measurement reaches background levels, which ever is greater.

3.1.2.4 Non-IHSS Area

Subsurface soil samples will be collected in the Non-IHSS Area to determine the depth of radiological contamination associated with the surface soil program. The number, location, and depth of subsurface soil samples to be collected will be determined following the analysis of the HPGe survey data. The analysis of HPGe data will provide the area of surface soils exceeding Tier I action levels.

The Non-IHSS area includes two areas where previous remedial actions have taken place. Remedial actions in 1976 and 1978 removed contaminated soils adjacent to the south side of the 903 Pad. Soils were removed adjacent to the Rocky Flat Alluvium pediment surface on the north hillside of Woman Creek Analytical confirmation samples were not collected to confirm the conditions of soils prior to import soil placement.

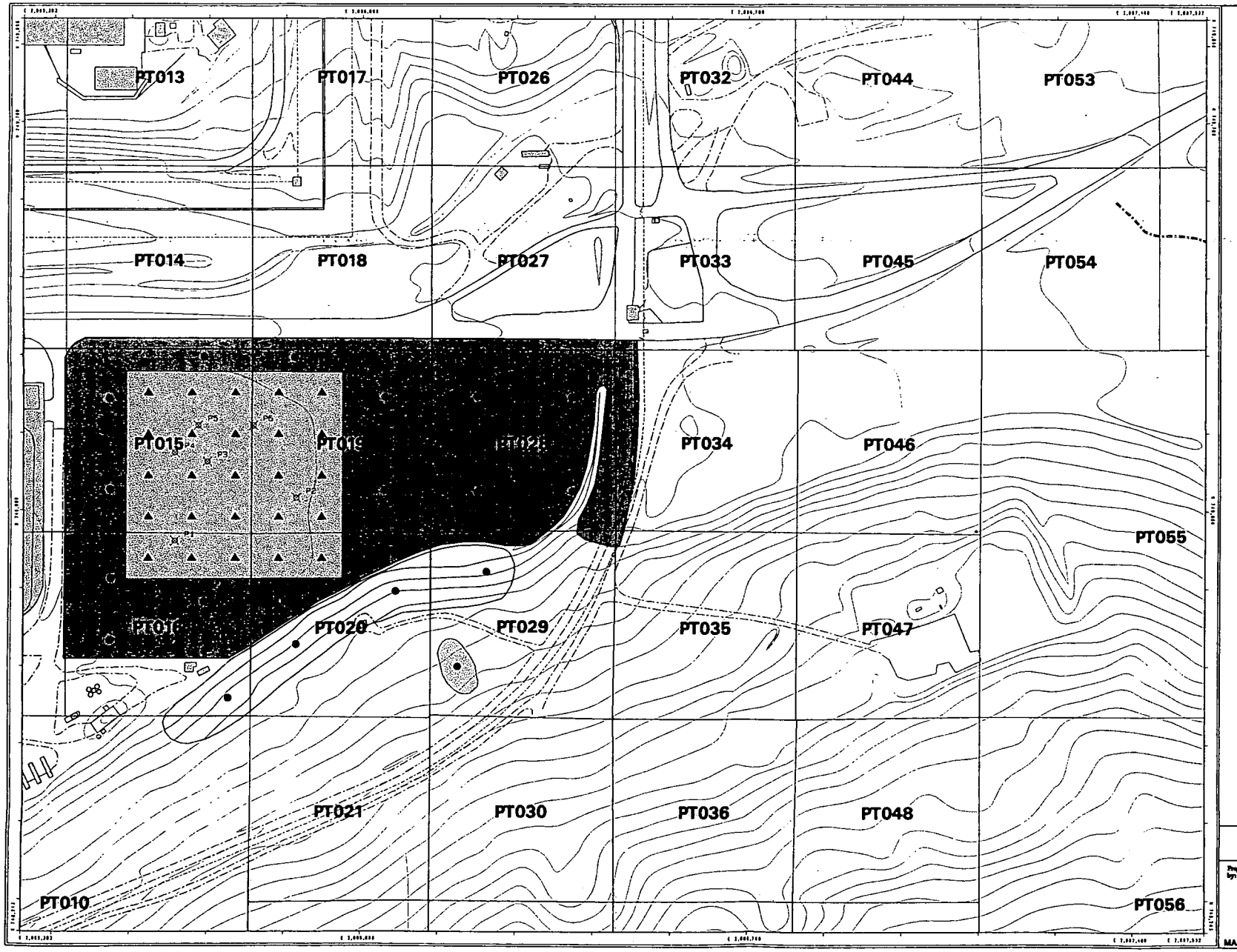


Figure 3-3

903 Pad, Lip Area and Non-IHSS Area Radiological Subsurface Sampling Locations

EXPLANATION

- 5-ft elevation contour
- 1975 Soil Removal Area (approx)
- 1978 Soil Removal Area (approx)
- 1970 Soil Fill Area
- 903 Pad Lip Area Boreholes
- 903 Pad Boreholes
- Surface Soil Sample Location

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSI, Las Vegas.
Digitized from the orthophotographs. 1:96

0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
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MAP ID: 97-0149

August 29, 1997

Therefore, subsurface soil samples are required to characterize this area. Four borings are proposed to characterize the 1978 remedial area. On soil boring is proposed to characterize the 1976 remedial area.

Table 3.3 provides an estimate of the number of boreholes and samples required to complete the subsurface radiological investigation program.

TABLE 3.3 SUBSURFACE SOIL RADIOLOGICAL INVESTIGATION - FIELD PROGRAM

AREA	BOREHOLES	REAL SAMPLES	FREQUENCY
903 Pad	25-Radiological Investigation 8 - Initial VOC (est.) 8 - Follow-up VOC (est.)	150 32(est.) 32(est.)	6 Inch Intervals 5 Foot Intervals 5 Foot Intervals
Lip Area	14-Radiological Investigation 3 Initial VOC (est.) 3 Follow-up VOC (est.)	56 12(est.) 12(est.)	6 Inch Intervals 5 Foot Intervals 5 Foot Intervals
Non-IHSS	5 - Soil Remediation Areas TBD - Additional borings based on HPGe results	20 TBD	6 Inch Intervals 6 Inch Intervals

TBD - To be determined following analysis of HPGe survey data.
est. - Estimated

Borehole estimates for the subsurface radiological contamination investigation at the 903 Pad are based on the placement of 25 borings on an 80 by 80 foot grid over the 3.4-acre area of the asphalt pad. Estimates on the number of boreholes required to investigate the VOC contamination at the 903 Pad are based on the assumption of four initial and four follow-up boreholes required to characterize contamination detected in groundwater at two wells locations on the pad.

Borehole estimates for the subsurface radiological contamination investigation at the Lip Area are based on the placement of one borehole in each quadrant of a surface soil plot (2.5-acre plot). Estimates on the number of boreholes required for the Lip Area VOC contamination investigation are based on the placement of three initial and three follow-up boreholes surrounding well 07191.

Borehole estimates for the Non-IHSS subsurface radiological contamination investigation are based on the placement of four boreholes in the area of 1976 surface soil remediation and one borehole placed in the 1978 surface soil remediation.

The analytical program for soils generated in support of the subsurface soil radiological investigation is provided in Table 3.4.

TABLE 3.4 RADIOLOGICAL SUBSURFACE SOILS CHARACTERIZATION -ANALYTICAL PROGRAM

ANALYTICAL METHOD	ANALYTES	CONTAINER	PRESERVATIVE	HOLDING TIME
Gamma Spectroscopy	Plutonium-239/240, Americium-241	500-mL wide mouth glass or poly jar	None	6 months
Uranium and Thorium Isotopic	Uranium, Thorium	Combine with Gamma Spectroscopy	None	6 months

3.2 VOC Investigation

Subsurface soil sampling at the 903 Pad will be implemented near existing groundwater monitoring wells 06691, and 08891 using a radial placement geometry with the well location serving as the center. Borehole 07191, which did not detect VOC contamination, will serve as the westernmost boring for the investigation of the soil gas anomaly at the southeast corner of the 903 Pad.

Initial boreholes will be located 20 feet from the respective well/borehole location being investigated. Figure 3.4 provides the locations of initial boreholes to be completed. Borehole locations will be spotted twenty feet to the north, south, east and west of locations 06691, and 08891. Borehole locations will be spotted twenty feet to the north, south, and east of borehole location 07191. Boreholes will be advanced from the ground or asphalt surface to a depth of one or two feet below bedrock. Samples will be collected at five foot intervals below ground surface (bgs), or at intervals where VOC are detected with field instrumentation. If VOCs are detected above ten ppm by field instrumentation, then the sampling grid will be extended an additional twenty feet to the north, south, east, and west of that location and additional samples will be collected for laboratory analysis.

If DNAPL is encountered, the follow-up boring step out distance will be reduced to 10 feet. This process will continue until the area of contamination above 10 ppm is defined. Follow-up borehole locations will be relocated in the field based on field results (i.e. if areas of high VOC contamination are found, additional borehole locations for soil sampling may be required to further delineate the extent of contamination). Table 3.5 provides an estimate of the number of boreholes and samples to be completed/collected by location.

TABLE 3.5 VOC SUBSURFACE SOIL CHARACTERIZATION FIELD PROGRAM

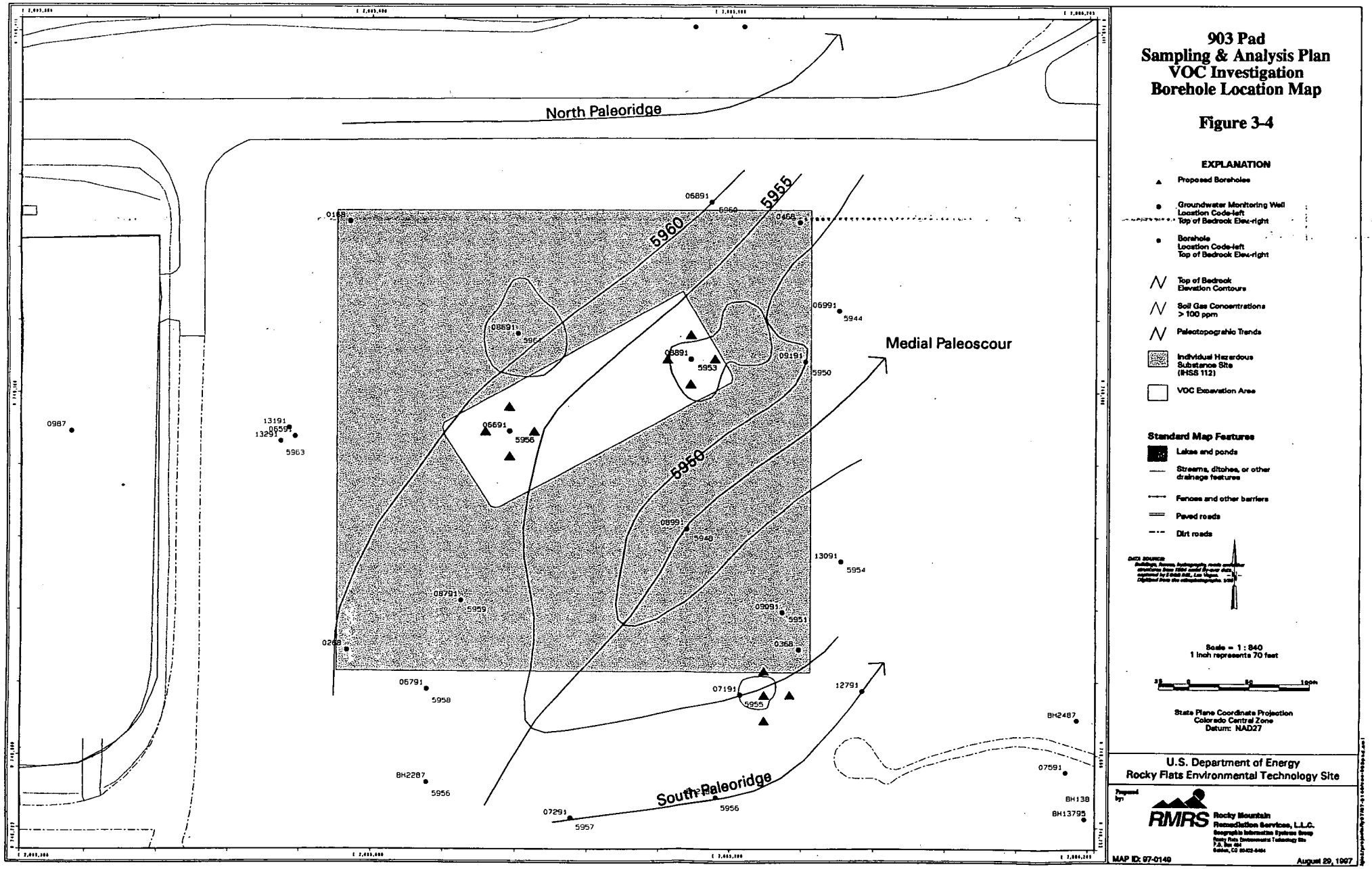
AREA	BOREHOLES	SAMPLES	FREQUENCY
903 Pad	8- Initial 8 -Follow-up (est.)	32 32 (est.)	5 Foot Intervals
Lip Area	3- Initial 3 -Follow-up (est.)	12 12 (est.)	5 Foot Intervals
Non-IHSS Area	0	0	0

Table 3.6 provides the analytical program for samples collected for the VOC contamination investigation.

TABLE 3.6 VOC SUBSURFACE SOIL CHARACTERIZATION ANALYTICAL PROGRAM

ANALYTICAL METHOD	ANALYTES	CONTAINER	PRESERVATIVE	HOLDING TIME
Gamma Spectroscopy	Plutonium-239/240, Americium-241	500-mL wide mouth glass or poly jar	None	6 months
Uranium and Thorium Isotopic	Uranium, Thorium	Combine with Gamma Spectroscopy	None	6 months
SW-846 Method 8240B/8260A	Volatile Organic Compounds	120-mL capped core, 4 or 8-oz. wide mouth glass jar. Teflon lined closure.	Cool, 4° C	14 days
SW-846 Method 8240B/8260A (Trip Blanks)	Volatile Organic Compounds	3 x 40-mL glass, Teflon lined septa cap.	Cool, 4° C HCl pH<2	14 days

SW-846(EPA, 1986) Test Methods for Evaluation Solid Waste Physical /Chemical Methods



903 Pad
Sampling & Analysis Plan
VOC Investigation
Borehole Location Map

Figure 3-4

EXPLANATION

- Proposed Boreholes
- Groundwater Monitoring Well
  Location Code-left
  Top of Bedrock Elev-right
- Borehole
  Location Code-left
  Top of Bedrock Elev-right
- Top of Bedrock Elevation Contours
- Soil Gas Concentrations > 100 ppm
- Paleotopographic Trends
- Individual Hazardous Substance Site (IHSS 112)
- VOC Excavation Area

Standard Map Features

- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads

DATA SOURCES

Scale = 1 : 840
1 inch represents 70 feet

0 35 70 140 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

RMRS Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0149

August 29, 1997

3.3 Sample/Data Collection and Handling

Prior to implementation of the field program procedure GT.25, Approval Process for Construction Activities on or Near Individual Hazardous Substance Sites (IHSSs) will be completed. Information collected in the field shall be handled according to FO.14, Field Data Management.

3.3.1 Sample/Data Collection

Surface Soils - HPGe measurements will be made at each survey location in accordance with Radiological Engineering Procedures (REP) 4-61100-REP-1401, Operation of Gamma Ray Spectroscopy Systems, and 4-R29-REP-1402, Routine Characterization of HPGe Detectors. FIDLER surveys will be conducted in accordance with ROI Manual, 4-H58-ROI-06.6, Use of Bicron FIDLER. Surface soil samples will be collected utilizing the RF method, as modified by this SAP, identified in GT.08, Surface Soil Sampling.

Subsurface Soils - The vertical extent of contamination shall be investigated through the completion of boreholes. Boreholes will be cleared for construction utilizing procedure GT.10, Borehole Clearing. Boreholes will be constructed according to procedure GT.02, Drilling and Sampling using Hollow-Stem Auger Techniques.

Borehole locations shall be cleared according to GT.10, Borehole Clearing. Boreholes will be completed by procedure GT.02, Drilling and Sampling Using Hollow-Stem Auger Techniques, or by GT.39, Push Subsurface Soil Sample. If hollow-stem auger techniques are selected, soil samples will be collected utilizing either continuous core auger sampling or continuous drive sampling, depending on which method provides the best percentage of core recovery. Boreholes will be logged according to procedure GT.01, Logging Alluvial and Bedrock Material. Boreholes will be abandoned by procedure GT.05, Plugging and Abandoning Boreholes.

3.3.2 Sample Handling

Sample collection and handling will follow Environmental Management Department (ERM) Operation Procedures Volume I Field Operations 5-21000-OPS-FO.13, Containerization, Preserving, Handling, and Shipping Soil and Water Samples. Samples will be transported to laboratories according to GT.25, Shipment of Radioactive Samples.

3.4 Equipment Decontamination/Waste Handling

Reusable sampling equipment will be decontaminated in accordance with EMD Operating procedure FO.03, Field Decontamination Procedures. Decontamination waters generated during the project shall be managed according to procedure FO.07, Handling of Decontamination Water and Wash Water. Drilling equipment shall be decontaminated between IHSSs using procedure FO.04, Decontamination of Equipment at Decontamination Facilities.

Drill cutting shall be handled according to procedure FO.08, Handling and Containerizing Drilling Fluids and Cuttings. Containers shall be labeled in compliance with F0.10, Receiving, Marking and Labeling Environmental Containers. Waste containers shall be managed by procedure FO.23, Management of Soil and Sediment Investigative Derived Materials (IDM).

Personal protective equipment shall be disposed according to procedure FO.06, Handling of Person Protective Equipment.

4.0 PROJECT ORGANIZATION

Figure 4.1 illustrates the project organizational structure for the implementation of the 903 Drum Storage Site, 903 Lip Area, and Non-IHSS Area SAP. With regard to this SAP, the RMRS Environmental Restoration Projects Group project manager will be the primary point of responsibility for maintaining data collection and management methods that are consistent with site operations. Other organizations assisting with the implementation of this project are: RMRS Groundwater Operations, RMRS Health and Safety, RMRS Quality Assurance, and Kaiser-Hill (K-H) Radiological Engineering, K-H Radiological Operations, and K-H APO.

The sampling crew personnel will be responsible for field data collection, documentation, and transfer of samples for analysis. Field data collections will include sampling and obtaining screening results. Documentation will require detailed field logs and completing appropriate forms for data management and chain-of-custody shipment. The sampling crew will coordinate sample shipment for on-site and off-site analyses through the APO personnel. The sampling manager is responsible for verifying that chain-of-custody documents are complete and accurate before the samples are shipped to the analytical laboratories.

5.0 QUALITY ASSURANCE

Quality Assurance (QA) objectives pertaining to RMRS programs, DOE data management practices, and EPA guidelines will be applied. The project manager will be in direct contact with the QA officer to identify and correct issues with quality affecting potential discrepancies.

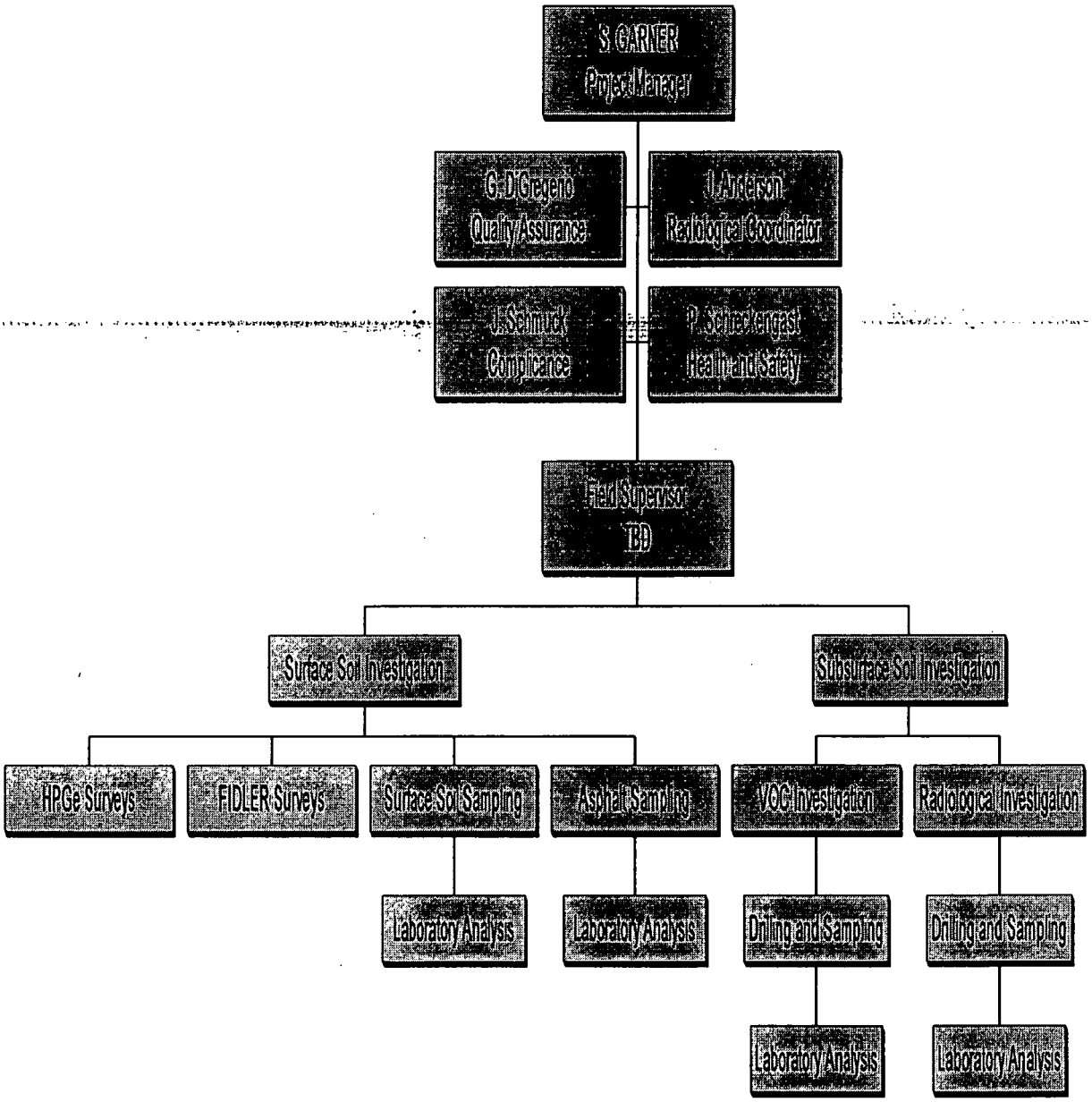
Field sampling quality control will be conducted to ensure that data generated from the samples collected in the field represent the actual conditions in the field. The confidence level of the data will be maintained by taking duplicate samples, equipment rinsate samples, and trip blanks. Duplicate samples will be collected on a frequency of one duplicate sample for every twenty real samples. Rinsate samples will be generated at a frequency of one rinsate sample for every 20 real samples collected. Trip blanks will accompany each shipment of VOC and TCLP samples generated for the project. Trip blanks will not be required for samples shipped for radiochemical analysis only. Data validation will be performed on 25% of the laboratory data according to the Rocky Flats Analytical Projects Office (APO), Analytical Services Performance Assurance Group procedures. Table 5.1 provides the QA/QC samples and frequency requirements of QA sample generation.

TABLE 5.1. QA/QC SAMPLE TYPE, FREQUENCY, AND QUANITY

SAMPLE TYPE	FREQUENCY	COMMENTS	QUANITY (estimated)
Duplicate	One duplicated for each twenty real samples		100
Rinse Blank	One rinse blank for each twenty real samples	To be performed with reusable sampling equipment following decontamination procedures	100
Trip Blank	One trip blank per shipping container	VOC and TCLP analysis shipments only	25

Analytical data that is collected in support of the of the 903 Pad SAP will be evaluated using the guidance developed by the Rocky Flats Administrative Procedure 2-G32-ER-ADM-08.02, Evaluation of ERM Data for Usability in Final Reports. This procedure establishes the guidelines for evaluating analytical data with respect to precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters.

FIGURE 4.1 PROJECT ORTANIZATION STRUCTURE



A definition of PARCC parameters and the specific applications to the investigation are as follows:

Precision

A quantitative measure of data quality that refers to the reproducibility or degree of agreement among replicate or duplicate measurements of a parameter. The closer the numerical values of the measurements are to each other, the lower the relative percent difference and the greater the precision. The relative percent difference (RPD) for results of duplicate and replicate samples will be tabulated according to matrix and analytical suites to compare for compliance with established precision DQOs. A 30% or less RPD is the goals for organic analyses and a 40% or less RPD is the goal for non-organics. Deficiencies will be noted, and if necessary, additional sampling and analysis may be conducted.

Accuracy

A quantitative measure of data quality that refers to the degree of difference between measured or calculated values and the true value of a parameter. The closer the measurement to the true value, the more accurate the measurement.

The actual analytical method and detection limits will be compared with the required analytical method and detection limits for VOCs and radionuclides to assess the DQO compliance for accuracy. If necessary, additional sampling and analysis will be conducted.

Representativeness

A qualitative characteristic of data quality defined by the degree to which the data absolutely and exactly represent the characteristics of a population. Reproducibility is accomplished by obtaining an adequate number of samples from appropriate spatial locations within the medium of interest.

The actual sample types and quantities will be compared with those stated in the SAP or other related documents and organized by media type and analytical suite. Deviation from the required and actual parameters will be justified, and if necessary, additional samples will be collected and analyzed.

Completeness

A quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained from a measurement system. A completeness goal of 90% has been set for this SAP.

Real samples and QC samples will be reviewed for the data usability and achievement of internal DQO usability goals. If sample data cannot be used, the non-compliance will be justified, and if necessary, additional sample collection and analysis will be performed.

Comparability

A qualitative measure defined by the confidence with which one data set can be compared to another. Statistical tests may be used for quantitative comparison between sample sets (populations).. At minimum, the project data sets will be compared against other real data sets (as appropriate) and background data. This is necessary to demonstrate compliance with DQO specifications and identify deficiencies. Deficiencies will be justified, and if necessary, additional sample collection and analysis will be conducted.

Quantitative values for PARCC parameters for the project are provide in Table 5.1.

TABLE 5.1 PARCC PARAMETER SUMMARY

PARCC	RADIONUCLIDES	NON-RADIONUCLIDES
Precision	Precision per APO Laboratory SOW	RPD $\leq$ 30% for Organics RPD $\leq$ 40 for Non-Organics
Accuracy	Detection Limits per APO Laboratory SOW	Comparison of Laboratory Control Sample Results with Real Sample Results
Representativeness	Based on SOPs and Work Plan	Based on SOPs and Work Plan
Comparability	Based on SOPs and Work Plan	Based on SOPs and Work Plan
Completeness	90% Useable	90% Useable

Laboratory validation shall be performed on 25% of the characterization data collected in support of this project. Data usability shall be performed on laboratory validated data according to procedure 2-G32-ER-ADM-08.02, Evaluation of ERM Data for Usability in Final Reports.

6.0 SCHEDULE

To be incorporated at a latter date.

7.0 REFERENCES

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903 DRUM STORAGE SITE (IHSS 112), 903 LIP AREA (IHSS 155), AND NON-IHSS AREAS DATA SUMMARY

Rocky Mountain Remediation Services, L.L.C

September 3, 1997

Revision No. 0

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

AEC	Atomic Energy Commission
ALF	Action Levels and Standards Framework
Am	Americium
bgs	Below Ground Surface
Ca	Calcium
CDH	Colorado Department of Health
Ci	Curies
cm	Centimeters
cpm	Counts per minute
DNAPL	Dense Non Aqueous Phase Liquids
DOE	Department of Energy
DOT	Department of Transportation
dpm/g	Disintegrations Per Minute/Gram
EPA	Environmental Protection Agency
ERM	Environmental Restoration Management
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FOV	Field-of-view
ft	Feet
g	Gram
HASL	Health and Safety Laboratory
HEPA	High Efficiency Particulate Air
HPGe	High Purity Germanium
IHSS(s)	Individual Hazardous Substance Sites
in	Inches
IM/IRA	Interim Measures/Interim Remedial Action
Kd	Coefficients
kg	Kilograms
Li	Lithium
m	Meters
mg	Magnesium
mrem	Millirem
Na	Sodium
PCB	Polychlorinated Biphenyl
pCi/g	Picocuries Per Gram
pCi/L	Picocuries Per Liter
ppb	Parts Per Billion
PPRG(s)	Programmatic Risk-based Preliminary Remediation Goals
Pu	Plutonium
RCRA	Resource Conservation and Recovery Act
RF	Rocky Flats
RFCA	Rocky Flats Cleanup Agreement
RFEDS	Rocky Flats Environmental Database
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RMRS	Rocky Mountain Remediation Services

ACRONYMS (Cont.)

ug/l	Micrograms Per Liter
VOC(s)	Volatile Organic Compounds
yd	Yard

1.0 PURPOSE

This document summarizes existing data which will be used to plan an accelerated remedial action for Individual Hazardous Substance Sites (IHSSs) and contaminated surface and subsurface soils including:

- 903 Pad Drum Storage Area (IHSS 112) (903 Pad),
- 903 Lip Area (IHSS 155),
- Reactive Metal Destruction Site (IHSS 140), and
- Buffer Zone OU (Non-IHSS) including the Americium Zone and OU 1 Surface Soils.

This document addresses contamination of the asphalt pad at IHSS 112, soils under the pad, as well as surface and sub-surface soils within the other locations within the study area identified above.

The purpose of the data summary is to present the data generated through numerous investigations, provide a usability assessment of these data, and use the information to assess RFCA action level exceedances.

This assessment, along with the qualitative survey information provided in this summary, will aid in the developing volume estimates to be used in future remedial action planning, probably through an IM/IRA. Because the large volumes of contaminated subsurface and surface soils requiring remediation, the future IM/IRA is expected to evaluate three remedial alternatives. These alternatives are:

- Excavation of VOC-contaminated soils at the 903 Pad for ex situ treatment, off site shipment of soils exceeding putback levels, and excavation of the remaining radiological contaminated soils for off site disposal.

- Excavation of VOC-contaminated soils at the 903 Pad for ex situ treatment, physical separation, off site shipment of soils exceeding putback levels, and excavation of the remaining radiological contaminated soils, physical separation for waste reduction purposes, and off site disposal.

- Excavation of VOC-contaminated soil beneath the 903 Pad for ex-situ treatment, replacing treated soils in excavation, excavation of radiological contaminated surface and subsurface soil beyond the 903 Pad area, transporting and placing soils at the 903 Pad excavation site for capping with engineered cover.

2.0 BACKGROUND AND PROJECT DESCRIPTION

2.1 903 Pad and 903 Lip Area (IHSSs 112 AND 155)

Drums that contained radioactively contaminated oils and volatile organic compounds (VOCs) were stored at the 903 Drum Storage Area (Figure 2-1) site from the summer of 1958 to January 1967 when this area was an open field. Drum storage at the 903 Pad occurred over the entire pad area, with the maximum number of drums stored in April 1965, based on historical photographs (RMRS 1995a). A description by Catkins (1970) of the drums that were stored at the drum storage site follows:

> "Most of the drums transferred to the field were nominal 55-gallon drums, but a significant number were 30-gallon drums that were not completely full. Approximately three-fourths of the drums were plutonium contaminated, while most of the balance contained uranium isotopes. Of those containing plutonium, most were lathe coolant consisting of a straight-chain hydrocarbon mineral oil (Shell Vitrea) and carbon tetrachloride in varying proportions. Other liquids were contained, including hydraulic oils, vacuum pump oil, trichloroethylene, perchloroethylene, silicone oils, and acetone still bottoms. Originally, contents of the drums were indicated on the outside, but these markings became illegible through weathering and no other records were kept on the contents. Oil leakage was recognized, and in 1959 (or possibly earlier) ethanolamine was added to the oil to reduce the corrosion rate of the steel drums."

As noted in Catkins (1970), drum leakage was observed at the 903 Pad Drum Storage Site as early as 1959. Initial corrective action consisted of transferring the contents of the leaking drums to new drums and installing a fence around the area to restrict access. Approximately 420 drums showed evidence of leakage, and of these, an estimated 50 leaked their entire contents (Dow Chemical, 1971). Approximately 5,000 gallons of liquid (Freiberg, 1970) containing an estimated 86 grams (g) of plutonium (5.3 Curies [Ci]) leaked into the soil (Dow Chemical, 1971).

A heavy rainstorm in August 1967 caused contaminants to migrate into a ditch south and southeast of the drum storage site (Dow Chemical, 1971). During an investigation conducted by the Atomic Energy Commission (AEC) Health and Safety Laboratory (HASL), it was estimated that as much as 125 g total of plutonium-239 (7.7 Ci) were released from the drum storage site and redistributed by winds (Krey and Hardy, 1970).

From 1968 through 1969, some of the radiologically contaminated soil material was removed, the surrounding area was regraded, and much of the area, including the 903 Lip Area, was covered with a clean road base. An asphalt cap was constructed over the fenced drum storage area in October 1969 (Frieberg, 1970).

During radiological monitoring of the 903 Pad in 1971, four "hot spots" were identified. This lead to the removal of 31 kilograms (kg) of depleted uranium and up to 10.3 milligrams (mg) of plutonium from beneath the asphalt cover. During sampling activities associated with this removal action, an oil layer, contaminated with depleted uranium, was discovered in two separate boreholes at depths of 45.7 and 76.2 centimeters (cm) (18 inches and 30 inches respectively) below ground surface (bgs). A clay layer was observed beneath the contaminated zone. Because no contamination was found below the clay layer, it was believed that the clay layer served as a natural barrier to downward migration of contaminants. However, the OU 2 RFI/RI (DOE, 1995) identified radiological contamination at decreasing concentration from 0.6 to 6 meters (2 to 10 feet respectively) at the 903 Pad.

During drum storage, removal and cleanup activities associated with the 903 Pad Drum Storage Site, wind and rain redistributed plutonium beyond the 903 Pad. Contamination was primarily to the south and east, extending to the southeast perimeter road creating IHSS 155, the 903 Lip Area (Figure 2-2). An estimated 16 g of plutonium-239/240 were redistributed beyond the asphalt pad, in an area exceeding 2,000 acres (RMRS, 1995). This area outside the 903 Lip Area is referred to as the Americium Zone.

2.2 Reactive Metal Destruction Site (IHSS 140)

The Reactive Metal Destruction Site, also know as the Hazardous Disposal Area is located on the hillside south of the 903 Pad. This site was used during the 1950s and 1960s primarily for the destruction and disposal of lithium (Li) metal. Approximately 400 to 500 pounds of metallic Li were destroyed on the ground surface in this area and the residues, primarily nontoxic Li carbonate, were buried. Smaller unknown quantities of sodium (Na), calcium (Ca), magnesium (Mg), solvents and unknown liquids were also destroyed at this location. Additionally, nickel carbonyl and iron carbonyl were potentially disposed in this area in 1969 (Illsey, 1978). Historical references do not indicate the method by which constituents were destroyed at the site.

2.3 Non-IHSS Areas and OU 1

Non-IHSS areas are identified as areas outside OU2 IHSSs which have been impacted by windblown contaminants. These areas are located east and south of the 903 Lip Area. The areas which underwent surface soil remediation activities in 1976 and 1978 are located in the Non-IHSS Area. Surface soils in OU1 have been administratively included into the Buffer Zone OU and evaluated with surface soils in the 903 Lip Area and Non-IHSS areas.

2.4 Physical Characteristics of the Study Area

The study area is located in the southeast portion of the Buffer Zone surrounding the RFETS. Surfical geologic units within the study area include alluvial, hillslope, and anthro-pogenic deposits. The 903 Pad, Lip Area, and Reactive Metal Destruction Site are located on the Rocky Flats Alluvium. Artificial fill is present at the 903 Pad and Lip Area. Non IHSS areas are

located within the Rocky Flats Alluvium and hillslope deposits. Geologic, hydrogeology and geochemisty of the study area may be found in numerous reports including:

- Final Phase II RFI/RI Report, 903 Pad, Mound, and East Trenches Area, Operable Unit No. 2. (DOE, 1995).
- Geologic Characterization Report for the Rocky Flats Environmental Technology Site (EG&G, 1995)
- Groundwater Geochemistry Report of the Rocky Flats Environmental Technology Site (EG&G 1995)
- Hydrogeologic Characterization Report for the Rocky Flats Environmental Technology Site (EG&G, 1995)

3.0 PREVIOUS INVESTIGATION RESULTS

Numerous investigations into the extent of radiological contamination in surface and subsurface soils have been conducted at the 903 Pad and 903 Lip Area. These investigations include the original groundwater monitoring wells installed in 1968, pre-surface 903 Drum Storage Area plutonium survey (Owens, 1968), post-surface 903 Pad gamma surveys (Rutherford, 1981), soil sampling beneath the 903 Pad (Stevens et. al., 1982), aerial radiological surveys (EG&G, 1989), ground radiological surveys (EG&G, 1990 &1994), surface soil sampling, and subsurface soil sampling in support of the OU 2 RFI/RI (DOE, 1995) as well as recent samples to support the actinide migration studies. These investigations are discussed below.

3.1 Surface Soil Investigations

Numerous surface soils investigations have been conducted within the study area beginning shortly after the removal of drums at the 903 Pad in 1969. The following sections provide a description on surface soil investigations conducted in the area.

3.1.1 Pre-903 Pad Plutonium Survey

J. B. Owen's (1968) correspondence to J. Seastone, provided in Appendix A, documents the results of a 1968 survey into the plutonium contamination at the 903 Pad. The correspondence describes the techniques used, conditions in the area during the survey, survey results, and Health Physics' recommendation for corrective action.

As described in Owen's correspondence, prior to the placement of the asphalt at the 903 Pad, a radiological survey was conducted which with readings taken on a 25-foot grid. The survey was conducted on relatively dry soils which were generally unvegetated inside the fenced area. Vegetation outside the fenced area was described as heavy and may have impacted the survey by preventing direct placement of the instrumentation on the ground surface. The correspondence states that the contamination was carried into the soil by a liquid and that the soil conditions

within the fenced area do not permit accurate penetration determination. However, "a spot survey in the southwest section indicated 60 micrograms (Pu) per square meter of pad area at a depth of 8 inches with no indication of having reached the limit of penetration".

For purposes of this data summary, these data are considered qualitative. Owens (1968) correspondence does not state the specific instrumentation used to perform the survey. It does state that information used to convert the survey results to micrograms per square meter was obtained from the Emergency Radiation Monitoring Team Training Manual. A map presenting the results of the survey in micrograms per square is provided in Figure 3-1 [from Owen's (1968)].

3.1.2 Pre-Surfaced 903 Drum Storage Area Plutonium Survey

Rutherford (1981) re-evaluated the 1968 survey. He concluded the 1968 survey measured the plutonium activity for 2-ft diameter circle (field of view). A map presenting the results of the survey is provided in Figure 3.1, however, the 903 Pad storage fence and buildings were not included. The relative position of the survey and resulting isopleths cannot be determined without review of the original map provided by Owen's (1968) (Figure 3.1).

3.1.3 Gamma-Ray Survey of Asphalt Pad

Rutherford (1981) also includes the results of a gamma survey conducted in 1971 on the surface of the asphalt pad. Four areas of contamination spots were sampled for radiochemical analysis. The analytical results indicated that no vertical migration had taken place and that contamination was restricted to 0 - 20 cm (0-68 inches) depth interval or less below the original ground surface. Analytical results were not published in the report. The gamma survey results indicated that "except for several areas that were sufficiently high in radioactivity to distinguish from background, the survey in general could not distinguish between contamination under the pad and natural radioactivity in the asphalt". A copy of the gamma survey map is provided as Figure 3-3.

3.1.4 High Purity Germanium (HPGe) Surveys

Numerous HPGe surveys have been conducted at the RFETS to provide a baseline radionuclide activity in surface soils and to determine subsequent impacts on surface soils at the RFETS. Summaries on the most recent HPGe surveys are provided below. These data provide the conceptual basis for assessing the volume of soil requiring remediation.

3.1.4.1 Aerial Radiological Survey of the US DOE's Rocky Flats Plant - July 1989

Allegations of a criticality accident at the site prompted an aerial HPGe radiological survey of the area in June of 1989 (EG&G, 1990). A series of parallel lines were flown over 48 square miles of the site. Specifically, the survey was oriented to cover the site and the natural drainage area leading away from the plant. The flights were conducted at an altitude of 150 ft above the ground surface with flight lines spaced 250 feet apart.

The survey consisted of airborne measurements of both natural and man-made gamma radiation from the terrain in and around the plant. These measurements allowed an estimate of the distribution of isotope concentrations in the survey area. Results are reported as contour maps of total terrestrial exposure rate, man-made count rate, americium-241 count rate, and cesium-137 count rate isopleths superimposed on aerial photographs of the area. The contours presented on maps represent concentration ranges of 0-50, 50-120, 120-240, 240-600, 600-2,400, 2,400-9,600, and 9,600-38,400 cpm.

The americium-241 map (Figure 3-4) presents 50-120 cpm contour intervals for the 903 Pad. The contours sharply increase from the 903 Pad to the Lip Area where they increase to concentrations of 600 to 2400 cpm. These concentrations decrease from the Lip Area eastward to 240 -600 cpm in a small area adjacent to the 903 Lip Area perimeter road. Concentrations gradually decrease to 50 cpm to the east with three isolated areas with higher concentrations (50-120 cpm) present 3,000 feet east of the 903 Pad.

Ground measurements were obtained at the same time as the aerial survey to correlate the two measurements. Ground measurements were obtained by either a truck mounted or a tripod mounted detector. In addition, soil samples were collected and analyzed at each ground measurement location. The report states that an excellent comparison of the activity concentration existed between the three analyses (soil samples, *in situ* HPGe, and aerial HPGe).

3.1.4.2 In-Situ Survey of the US DOE's Rocky Flats Plant

In 1990, an *in-situ* radiological survey was performed over RFETS (EG&G, 1991). The area east of the 903 Lip Area was surveyed from November 8 through December 8, 1990. The survey was conducted utilizing a 20% N-type, HPGe gamma ray detector suspended 7.5 meters above ground surface. Measurements were obtained with a field of view with 150-foot centers. The results assume a homogeneous, three-dimensional distribution of the species within the soil matrix and averaged over the top 3 cm (1.2 in.) of soil. No soil samples were collected in support of this field effort.

The results, presented as isoconcentration contours, indicate americium-241 activities ranging from 1 pCi/g to 60 pCi/g adjacent to the road west of the 903 Lip Area. Figure 3-5 presents the map generated for the report.

3.1.4.3 1994 In-Situ HPGe Survey of the 903 Pad and 903 Lip Areas

A truck-mounted HPGe survey was conducted in June 1994 (RMRS, 1996) over part of the Americium Zone east of the 903 Pad and over the 903 Lip Area. The survey measured the average activity of actinides over a specific field-of-view (FOV) of 150 feet in diameter. The survey identified 35 FOV locations, many which are contiguous, where estimated amerinium-241 activities were above 10 pCi/g (Figure 3-6). The HPGe survey of the area east of the 903 Lip Area correlates very well with the HPGe survey conducted in 1990 by EG&G. This correlation was observed by comparing no concentration maps from Figure 3-5 with HPGe measurements presented in Figure 3-6.

3.1.5 RFI/RI Surface Soil Investigations

The CDH sample method involves collection of 25 group samples over a 2.5-or 10-area plot, with a sample depth of 0.64 cm. The 25 grab samples are composited for the plot. The RF sampling method collects a soil sample to 2 inches in depth. The RF sampling method involves the compositing of 10 grab samples collected over a 3 square meter area in the center of each 2.5- or 10-area plot. The RF method was conducted by collecting one composite sample at the center of each plot previously sampled using the CDH sampling method. Figure 3-7 illustrates how the samples are collected for each of the two methodologies.

Investigations for the OU 2 Phase II RFI/RI and OU 1 Phase III RFI/RI included collection of surface soils from the study area. The OU 2 Phase II RFI/RI included the collection of surface soils from 118 plots and 26 soil profile pits. Surface soil samples from plots were collected utilizing both the CDH and RF methods. Soil profile pits were sampled using a trenching method.

Surface soil samples were collected from 34 plots for the OU 1 Phase III RFI/RI. The samples were collected utilizing a modified RF method. The modification included the compositing of RF samples collected at five locations within each selected plot.

Surface and subsurface soil radiological data were evaluated according to Procedure 2-G32-ER-ADM-08.02, Evaluation of ERM Data for Usability in Final Reports. The procedure is based on the relationship of data to the data quality objectives. This evaluation determines the adequacy of radiochemistry data for use in environmental decision making. Numerous data were deleted from the data set based on this evaluation. Appendix B provides the draft report presenting the results of the usability evaluation (RMRS, 1997).

Surface soil contamination levels were compared against RFCA Tier I soil action levels to establish an estimate on the areal extent of contaminated soils requiring remediation. This scenario assumes an annual radiation dose of 85 millirem (mrem). If a mixture of radionuclide contaminants a, b, c are present in the soil in the activities a_a, a_b, and a_c and if the applicable

action level of radionuclide in soil, as stated in RFCA, is A_a, A_b, and A_c respectively, then the activity in the soil shall be limited so that the following relationship exists:

$$\frac{a_a}{A_a} + \frac{a_b}{A_b} + \frac{a_c}{A_c} \leq 1 \qquad \text{(eq. 2.1)}$$

If the sum of ratios, as calculated in the equation 2.1, exceeds 1, this will trigger an evaluation, remedial action, and/or management action.

Table 3-1 presents the RFCA Tier I action levels for specific radionuclides using the Buffer Zone hypothetical resident scenario.

TABLE 3-1

RFCA ALF TIER I SOIL ACTION LEVELS - RADIONUCLIDES

Radionuclide	Activity (pCi/g)
Americium-241	215
Plutonium-239/240	1429
Uranium-234	1738
Uranium-235	135
Uranium-238	586

3.1.5.1 CDH Sampling Method - Spatial Extent/Fate and Transport Study

The CDH sampling method was conducted to determine the spatial extent of radiological contamination within OU 1 and OU 2. Four 2.5-acre plots (Plots 21, 22, 30, and 31) and seven 10-acre plots (Plots 0, 1, 3 ,4, 10, 11,and 23) were sampled in support of the OU 1 Phase III RFI/RI (DOE, 1994). The remaining 107 plots were sampled in support of the OU 2 Phase II RFI/RI (DOE, 1995). Figure 3-8 provides the locations of the plots sampled in support of these programs.

These data were summarized in Litaor (1995a). Isopleth maps were generated for plutonium-239/240 and americium-241from these data. Litaor (1995b) also evaluated isotopic uranium data generated from this investigation. Most of the observed activities of U-234 and U-235 were well within the natural range of U isotopes in soils. Uranium-238 exhibited a pattern of localized spatial distribution, however, most of the observed activity was well within the natural range of U-238 activity in soils.

Table 3-2 provides analytical results for radionuclides from the OU 2 Phase II RFI/RI and RFCA Tier I ratios and sum of ratios for the samples collected using the CDH sampling method. The

results indicate that the sum of ratios for radionuclides from two 2.5 acre areas, Plots 28 and 34, exceed RFCA Tier I action levels. Based on the nature of the sampling method, the analytical results represent the physical average of radionuclides in the respective plot. Figure 3-9 provides the locations of plots exceeding RFCA Tier I action levels for radionuclides.

3.1.5.2 RF Sampling Method - Spatial Extent/Fate and Transport Study

A comparative study was conducted to assess actinide activity using the CDH and RF sampling methods. This included the sampling of 118 plots identified in the OU 2 Phase II RFI/RI report using the RF sampling method. However, only data from 107 plots were available.

Plutonium-239/240 data from 103 plots and americium-241 data from 93 plots were determined to be useable based on an evaluation of radiological data (Appendix B). It was determined that differences in radionuclide results determined from the CDH sampling and RF sampling methods were not statistically significant (Litaor, unpublished).

Table 3-3 provides analytical results for radionuclides and RFCA Tier I ratios and sum of ratios for samples collected for the RF sampling program. The surface soil results indicate that the sum of ratios for radionuclides from three 2.5 acre areas, Plots 29, 36, and 46, exceed RFCA Tier I action levels. Based on the nature of the sampling method, the analytical results represent the physical average of radionuclides over the area sampled or 3 square meters at the center of each plot. Figure 3-10 provides the sample locations using the RF sampling method exceeding the RFCA Tier I surface soil action levels.

3.1.5.3 OU 2 Modified RF Sampling Method - Human Health Risk Assessment Study

An additional investigation was conducted to assess the potential human health risks associated with exposure to OU 2 surface soils. This investigation was designed to evaluate the nature and extent of non-radioactive contamination (SVOCs, metals, and pesticides/PCBs) as well as radioactive contamination, excluding americium-241, plutonium-239/240, and uranium-isotopes. Radionuclides analyzed for this investigation include cesium-134, -137, gross alpha, gross beta, radium-226, radium-228, and strontium-89, -90.

The OU 2 study area was divided into 9,126 contiguous 50 feet by 100 feet plots. Forty plots were systematically selected for sampling. Six of the forty were biased plots selected for sampling because they were located within IHSSs potentially containing contaminated surface soils. The remaining 34 plots were evenly spaced throughout the OU 2 area. One composite sample was collected from each of the plots using a modification of the RF method. The locations of the soil samples collected in support of the human health risk assessment study are provided in Figure 3-11.

Non-radiological compounds in surface soils were found to be less than the Tier I action levels and therefore do not require any action under RFCA.

3.1.5.4 OU 2 Soil Profile Sampling Program

Twenty-six soil profile pits were excavated and sampled to determine actinide distribution, fate and transport in soil for the OU 2 Phase II RFI/RI. Figure 3-12 provides the pit sample locations. Ten soil samples were collected per pit for the following depth intervals (in cm): 0-3, 3-6, 6-9, 9-12, 12-18, 18-24, 24-36, 36-48, 48-72 and 72-96. (Per RFCA, the top 6 inches (15.24 cm) is considered surface soil.) Samples were analyzed for plutonium-239/240, americium-241 and uranium-233/234, -235, and -238. More than 90% of the plutonium-239/240 and americium-241 activities were confined to the upper 12 cm of the soil, regardless of the soil characteristics or distance and direction from the source (Litaor et. al., 1994).

Table 3-4 provides analytical results for soil profile radionuclides and RFCA Tier I ratios and sum of ratios for samples collected from these pits. The soil sample results indicate that only samples from Pit TR 08 exceed RFCA Tier I action levels sum of ratios for radionuclides to a depth of 27 cm (10.68 in.). Table 3-5 provides the sum of ratios for radionuclide samples collected from Pit TR08. Pit TR08 is located in Plot 28 where CDH samples exceed Tier I soil action levels. Samples collected from Pit TR06 (Figure 3-12) exceeded DOT shipping restrictions and were not analyzed. Pit TR06 is also located in Plot 28. It is assumed that radiological contaminants exceed Tier I action levels below the surface soil level of 15 cm at this location due to its exceedance of the DOT shipping restrictions.

TABLE 3-5

SOIL PROFILE PIT TR08
RFCA TIER I SUM OF RATIOS COMPARISON - RADIONUCLIDES

Pit No.	Depth (cm)	Sample Number	Sum of Ratios
TR08	0-3	TR00332WCU2	7.7843
TR08	3-6	TR00331WCU2	3.2948
TR08	6-9	TR00330WCU2	3.2540
TR08	9-12	TR00329WCU2	7.6719
TR08	15-21	TR00328WCU2	2.0584
TR08	21-27	TR00327WCU2	2.2325
TR08	33-39	TR00326WCU2	0.4119
TR08	45-51	TR00325WCU2	0.0165
TR08	69-75	TR00324WCU2	0.0013
TR08	93-99	TR00323WCU2	0.0099

3.1.5.5 OU 1 Surface Soil Sampling Program

In addition to the 11 plot samples collected in OU 1 during the OU 2 Phase II RFI/RI field effort, surface soil samples were collected for the OU 1 RFI/RI. The OU 1 Phase III RFI/RI Surface Soil Sampling Program was designed to determine the nature and extent of contamination and assess potential human health risks from exposure to the soils. Samples were collected over a grid covering approximately 52 acres. The OU 1 area was divided into 450, 50- by 100-foot contiguous rectangle plots, which were sequentially numbered. Twenty-four of the plots were selected for sampling using a random number generating process. Four additional sampling locations were also selected to characterize IHSSs 106, 130, 119.1 and 119.2.

The samples were collected utilizing the RF sampling method (Explained in Section 3.1.5). Table 3-6 provides analytical results, RFCA Tier I values and sums of ratios for samples collected for this program. Figure 3-13 provides the locations of the soil sampling plots.

3.1.6 Ongoing Surface Soil Investigations

RFCA sets forth action levels and standards which incorporate land- and water-use controls in RFETS cleanup decisions. The soil action levels are calculated using a radiation dose limits based upon certain land use restrictions. The soil action levels were not intended to consider the transport of soil containing actinides to surface water. RFCA states that the protection of surface water usage with respect to long-term Site condition will be the basis for making soil and groundwater remediation and management decisions. Therefore, it is necessary to develop a conceptual model to better understand the relationship of the actinide levels in soils and the effect of remedial activities on the long-term protectiveness of surface water quality.

In 1996 the Actinide Migration Expert Panel was formed to review existing data on actinide migration at RFETS and make recommendations for future work. Their recommendations included activities to:

1) Develop a conceptual model for actinide transport, based on a thorough understanding of chemical and physical processes;
2) Investigate the long-term impacts of actinide geochemistry mobility on remedial requirements; and
3) Evaluate the protectiveness of the RFCA soil action levels to surface water quality.

In June 1997 the Actinide Migration Expert Panel collected 6 surface and subsurface soil samples located in Plot 34 (Figure 3-8). The purpose of the investigation was to provide preliminary plutonium phase speciation and soil distribution coefficients (K_d) values for 903 Pad area soils. A final report is to be delivered to Kaiser-Hill by September 30, 1997.

3.2 Subsurface Soils Investigation

Subsurface soils are defined in RFCA as soils deeper than six inches below the ground surface. Subsurface soils were investigated through soil gas surveys, borehole sampling programs, and soil pit investigations.

3.2.1 Initial Testing of Pilot Scale Equipment for Soil Decontamination Project

This report provided data identifying radioactive contamination, specifically plutonium-239 and americium-241, beneath the 903 Pad. Six samples were collected under the 903 Pad, identified as P-1 through P-6. The locations of these samples, provided by Rockwell (1977), are presented in Figure 3-14. The samples were collected to a depth required to reach a soil activity $\leq$250 dpm/g as detected by field instrumentation and may represent the vertical extent of radioactive contamination beneath the 903 Pad. The results were compared to RFCA Tier I action levels. Results of the sample analyses and Tier I sum of ratios are provided in Table 3-7.

Two additional samples, Samples A and B, were taken adjacent to the southeast corner of the 903 Pad in windblown soil material prior to the placement of the asphalt cap. However, exact locations of these samples has not been determined.

TABLE 3-7

SOIL DECONTAMINATION SAMPLING PROGRAM
RFCA TIER I SUM OF RATIOS COMPARISION - RADIONUCLIDES

Sample	Total Sampling Depth* (m)	Pu-239 (dpm/g)	Pu-239 (pCi/g)	Am-241 (dpm/g)	Am-241 (pCi/g)	Tier I Sum of Ratios
A	Surface	1,200	540	330	90	0.80
B	Surface	11,900	5,360	1,400	636	6.71
P-1	0.46	940	423	620	279	1.59
P-2	0.61	1,400	631	1,100	495	2.74
P-3	0.56	8,000	3,604	1,000	450	4.62
P-4	0.66	4,500	2,045	4,200	1,892	10.23
P-5	0.61	14,000	6,306	4,100	1,846	13.00
P-6	0.61	17,000	7,658	5,000	2,252	15.83

* Below top of asphalt.

3.2.2 RFI/RI Subsurface Soil Investigations

The OU 2 Phase I & II RFI/RI investigation included the completion of a number of boreholes and soil profile pits. The following sections provide the results of these subsurface investigations.

The OU 2 Phase I RFI/RI field program was completed in 1987 and a Draft Remedial Investigation Report for 903 Pad, Mound, and East Trenches Area (Rockwell International, 1987) was submitted to the EPA and CDH in December of 1987. Soil samples were collected for two-foot intervals from a total of 33 boreholes to evaluate the nature and extent of soil contamination. No surficial (0-6 in.) soil samples were collected in support of this investigation. The Phase I RFI/RI field investigation lead to the general conclusions that VOC and radionuclide contamination exists in soil, surface water, groundwater, and sediments around several IHSSs, but the distribution and magnitude of the contamination needed to be better delineated.

The OU 2 Phase II RFI/RI investigation involved collecting additional borehole samples, surface soil samples and installing groundwater monitoring wells. The following discusses the results of the Phase I and II RFI/RI in relation to the study area.

3.2.2.1 Borehole Programs

903 Pad - Seven source boreholes (Figure 3-15) (06691, 08691, 08791, 08891, 08991, 09091, and 09191) were installed at the 903 Pad in support of the OU 2 Phase II RFI/RI. Analytical data from samples collected from these borings was compared to RFCA action levels. The sum of ratios for radionuclide results indicate that all sample results were below the RFCA Tier I action levels. Table 3-8 provides the sum of ratio values for borehole samples collected in support of the OU 2 Phase II RFI/RI. No VOC concentrations above the RFCA Tier I action levels were detected.

903 Lip Area - Fifteen source boreholes and three additional boreholes for installation on groundwater plume characterization wells (00191, 06591, 06791, 06891, 06991, 07091, 07191, 07291, 07391, 09391, 09591, 13091, 34591, 34791, BH2287, BH2387, BH2487, BH3087) were installed in the 903 Lip Area (DOE, 1995). Data were available from RFEDS on all samples collected from these boreholes with the exception of boreholes 00191, 34591, and 34791. Radiological results from boreholes 09391 and 09591 were rejected during validation and, therefore, eliminated from the data summary database. The useable sample results were compared to RFCA Tier I action level and the sum of ratios for radionuclides were calculated. No sample sum of ratios for radionuclides exceed the Tier I action levels.

Reactive Metal Destruction (IHSS 140) - Nine source boreholes (07491, 07591, 07691, 0991, 09791, 12791, BH2687, BH2787, BH2887) were completed. Data from these boreholes were compared to the RFCA Tier I action levels for radionuclides. The comparison results indicated that no samples exceed the action levels for radionuclides.

903 Pad Source Area (Western Portion) (Non-IHSS Locations) - Seventeen boreholes (00291, 00391, 00491, 00591, 00691, 00791, 00991, 01091, 01191, 01291, 05991, 11791, 12991, 13591, 20791, B315289, BH2987) were completed in the area east of the 903 Pad. These borehole locations are primarily east and south of the 903 Pad on the south-facing slope of the Woman Creek drainage. However, radiological soil sample results from only three locations 00291, BH2987, and B315289 were available. RFCA Tier I comparisons indicate that no subsurface soil samples from these boreholes exceed the action levels.

3.2.2.2 OU 2 Soil Profile Sampling Program

Soil Profile (Pits 1-26) Sampling Program - The soil profile sampling program was conducted in support of the investigations of actinide distribution, fate and transport in soil for the OU 2 Phase II RFI/RI. Ten soil samples were collected at predetermined intervals to a depth of 1 meter at all locations. Soil profile sampling has been previously discussed in the surface soil section above. Samples from only one location, Pit TR08, exceed RFCA Tier I action levels to a depth of 27 cm (10.68 in.). This pit is located in Plot 28, also identified as exceeding Tier I soil action levels based on the CDH sampling program. In addition, samples collected from Pit TR06 exceed DOT shipping restrictions and were not analyzed. Pit TR06 is also located along the western edge Plot 28. Figure 3-12 provides the pit sample locations exceeding the RFCA Tier I surface soil action levels.

3.2.3 OU 2 Soil Vapor Survey

A soil gas study (DOE, 1994) was conducted in May/June 1993 to locate high VOC concentrations in the subsurface soil for the OU 2 soil vapor extraction project. The soil gas survey sampled areas where aerial photos taken prior to capping of the 903 Pad showed stained soils.

The soil gas survey consisted of 71 samples collected at a depth of 5 feet bgs during the summer of 1993 and one location sampled at a depth of 10 feet bgs in January 1994. The samples were collected and analyzed using portable gas chromatography. The survey observed the highest concentrations immediately south of the southeast corner of the 903 Pad, at 27,000 ug/l tetrachloroethene at a depth of five feet. However, at the adjacent soil gas locations and subsequently completed boreholes, tetrachloroethene was either not detected or detected at very low concentrations. Soil gas concentrations for the rest of the 903 Pad ranged from 0 to 500 ug/l with the next highest concentrations near boreholes 08891 and 08691 (see Figure 3-16).

3.3 Groundwater

Groundwater results are used to confirm the radiological & VOC contaminated areas and are available beginning in 1975. The Site groundwater monitoring program continues to monitor numerous wells within the study area. Results from groundwater monitoring programs are provided below.

3.3.1 Original Groundwater Monitoring Wells

Four groundwater monitoring wells were installed at each corner of the 903 Pad in 1968. The wells were installed above the water table at the site and reportedly seldom encountered groundwater. Yoder (1981) provides radioactivity data on these wells semi-annually from May 1975 to March 1981. These data indicate all wells were dry during this time period with the exception of wells 0168 and 0268 for the April 1980 sampling event. Groundwater samples from both wells were below the detection limits (shown in parentheses) for plutionium-239/240 (0.04 pCi/L), americium-241 (0.9 pCi/L) and total uranium (0.07 pCi/L). Tritium was detected at 1,400 pCi/L in well 0168 and at 80 pCi/L in well 0268.

3.3.2 Groundwater Contamination

High concentrations of VOCs are present in groundwater samples collected from wells at the 903 Pad. Concentrations up to 10 percent of the pure phase solubility of these compounds and substantially above RFCA Tier I action levels for groundwater were detected. The EPA (1992) provides guidance in Estimating Potential for Occurrence of Dense Non Aqueous Phase Liquids (DNAPL) at Superfund sites for determining the likelihood of DNAPL at a site. Based on the conditions of historical site use and characterization data, there is a high potential for DNAPL at the 903 Pad site.

A VOC-contaminated groundwater plume extends from the 903 Pad area to the east. The highest concentrations are found in groundwater samples collected from wells 06691 and 08891 located on the asphalt portion of the 903 Pad (Figure 3-15). Table 3-9 provides analytical results of groundwater samples collected from wells in the 903 Pad area. Concentrations of contaminants in groundwater drop rapidly east of the 903 Pad area. The primary groundwater contaminant in well 06691 is carbon tetrachloride and concentrations have ranged from 51 to 100,000 ppb. Also present are methylene chloride (150 to 35,000 ppb) and chloroform (92 to 49,000 ppb). Groundwater sample results for well 08891 indicate the primary contaminant as tetrachloroethene at concentrations ranging from 470 to 20,000 ppb, along with carbon tetrachloride (290 to 17,000 ppb), cis-1,2,dichloroethene (94 to 2,900 ppb) and trichloroethene (210 to 4,600 ppb). The next highest concentration of carbon tetrachloride in groundwater is found in samples collected from well 13191, which is located west of the well 06691 and off the western edge of the 903 Pad. At this location, observed carbon tetrachloride levels ranged from 122 to 4,800 ppb.

Radionuclide contamination in groundwater was analyzed from 1991 to 1995 for the groundwater monitoring wells identified as containing VOC contamination discussed above. Groundwater analytical data indicates that one well, 09091 located on the 903 Pad, contains americium and plutonium activity in excess of Tier I action levels for groundwater. This well contains groundwater with maximum activities of 46.54 pCi/L of plutonium-239/240 and 354.6 pCi/L of americium-241. No groundwater collected over this period detected any uranium-isotope in excess of its respective background activity. Table 3-10 provides analytical data for radionuclides in groundwater samples with detections above Tier II action levels.

3.4 Previous Remedial Actions

3.4.1 Surface Soils

Surface soil remedial actions have taken place at the site beginning in 1968 with the regrading (removal) of contaminated soils from outside the 903 Drum Storage Area. Surface soil removal actions have also taken place in 1976, 1978, 1984, and 1995. The following sections provide summaries on previous removal actions within the study area.

3.4.1.1 Initial Remedial Actions

Frieberg (1970) provides a chronology of the initial remedial actions taken at the 903 Drum Storage Area. The correspondence (Appendix C) provides the following information:

Date	*Activity*
July 1968	*A survey was conducted of the plutonium contamination on the surface of the soil in the 903 Area. The results of the survey and the Health Physics' recommendations for the containment of the contamination were sent to Division Services, Manufacturing and Facilities.*
October 1968	*Weeds and vegetation were burned off the 903 drum storage area in preparation of applying an asphalt cap.*
November 1968	*Grading of slightly contaminated soils outside the hot fence was conducted in preparation to applying an asphalt cap over the area. This work consisted of moving the slightly contaminated soils outside the fence into the fenced area in preparation of the cap.*
January 1969	*The hot fence was packaged and shipped as waste.*
February 1969	*Three more waste crates were packaged and shipped from the 903 Area.*
April 1969	*Two highly contaminated fork lifts were placed into wooden crates and shipped as hot waste.*
May 1969	*33 drums of contaminated rocks were removed from the 903Area and discarded as hot waste. Building 904 was decontaminated and removed to a location east of the Fire Barn. The road grader used to move*

Date	*Activity*
	contaminated soils was decontaminated and released to surplus.
July 1969	*Building 903 was moved to a location immediately east of Building 666.*
September 1969	*The base course material overlay, the soil sterilant, and the asphalt primer cat were completed for the 903 containment barrier (cap).*
October 1969	*The asphalt cap was applied.*
November 1969	*The four groundwater monitoring wells were installed.*
February 1970	*Operations were initiated to apply additional fill over the surrounding area directly east of the 903 Pad due to soil contamination.*
March 1970	*Additional fill operations were completed.*
April 1970	*As of April 3, no water was detected in any of the wells installed.*

This correspondence confirms that contaminated soils outside the 903 Drum Storage Area fence were graded into the fenced area prior to the application of the asphalt of the 903 Pad. In addition, the correspondence states that the contaminated area east of the 903 Pad, was covered with a base coarse material.

3.4.1.2 1975 Remediation Effort at the 903 Lip Area

In 1973, an aerial radiological survey detected radiological concentrations in the 903 Lip Area that were greater than 2,000 counts per minute (cpm). On May 13 and 14, 1975 personnel excavated two trenches in the 903 Lip Area as a pilot scale test for soil removal techniques (Barker, 1982). The locations of these trenches and depths of the excavations was not described. Eight 55-gallon drums of soil were removed from the 903 Lip Area. Ambient air monitoring during excavation did not detect plutonium in concentrations that would endanger onsite workers, the public, or the environment. Based on the results of this removal effort, a plan for removing the plutonium contamination from the 903 Lip Area was developed and work commenced the summer of 1976.

3.4.1.3 Removal of Plutonium-Contaminated Soil from the 903 Lip Area During 1976 and 1978

In 1976, approximately 113.3 cubic meters (4,000 cubic feet) of soil were removed from within the 903 Lip Area (Barker, 1982). The removal operation was conducted within a 8 foot by 16 foot floorless metal building equipped with a high efficiency particulate air (HEPA) filter. Contaminated soil was hand excavated from one small area at a time and placed in plastic bags. The bags were placed in full crates for off site shipment and disposal. The excavated area was surveyed with a Field Instrument for the Detection of Low Energy Radiation (FIDLER). The process was repeated until contamination levels were below the "detection limit" of the FIDLER (~250 cpm in the Lip Area). The excavated area was covered with clean topsoil and re-seeded with native grasses.

Soil removal activities were conducted again in 1978 when an estimated 4,000 square meters (43,000 square feet) of soil that exceeded 2,000 cpm was removed to a depth of approximately 3.5 cm (1.4 in.). This effort utilized heavy equipment including a front end loader, grader and bulldozer. Hand digging was only conducted in areas that were inaccessible to heavy equipment. Prior to excavating soils the area was premoistened by a sprinkler system for three days. A moisture content of 15% was required prior to excavation activities to prevent dust generation. The report states that all soils in excess of 2,000 cpm, as determined by the FIDLER, were removed. Excavated areas were resurveyed and soil was removed until background (~250 cpm as determined by the FIDLER) was reached. All waste was packaged and shipped to the Nevada Test Site. The excavated area was backfilled and revegetated. Figure 3-17 provides the locations of areas where soil removal activities have completed under these remedial efforts.

3.4.1.4 1984 Inner East Gate Soil Removal Project

Anomalous results were being recorded in air monitors, S7, S8, and S9, positioned along the fence. A dust suppressant was placed on the ground to determine if the anomalies were a result of the resuspension of soil. The air monitor results dropped after the placement of the suppressant, and a removal action was implemented. In 1984, soil cleanup was performed along the eastern edge of the 903 Lip Area parallel to the fence (Setlock, 1984). Soils were removed 8 to 10 feet on either side of the fence line from the previous inner east gate to 30 or 40 feet south of air sampler S-9, the southernmost air sampler. Soil was removed to a depth of one to two feet and the excavation was backfilled with clean topsoil. A total of 214 tri-wall pallets of contaminated soil was removed from the area.

3.4.1.5 Accelerated Response Action Completion Report, Hot Spot Removal, OU 1

While not related to the 903 Pad contamination source, an accelerated action for the removal of radionuclide-contaminated soils (hot spots) was conducted at six specific locations within OU 1 (DOE, 1995). The hot spots were localized, shallow, contaminated soils that contained substantial activities of either plutonium/americium or uranium, as well as trace amounts of organic compounds related to drum storage in IHSS 119.1. The Accelerated Response Action included excavating, containerizing, storing and disposing of the contaminated soils from the hot spots. Twenty-one 55-gallon drums of radionuclide-contaminated soils were removed under this action. The soils were transported and disposed off site. Figure 3-18 provides the locations of soil samples which identified hot spots in OU 1.

3.4.1.6 Subsurface Soils

Ryan's Pit (IHSS 109) - Ryan's Pit was used from approximately 1966 to 1970 for the disposal of VOCs and small quantities of debris (e.g. drum carcasses). While the contamination is not associated with the contamination source at the 903 Pad. Figure 3-19 provides the location of Ryan's Pit in relation to the 903 Pad. It is located within the 903 Lip Area. The pit measures

approximately 32 feet long and 18 feet wide. Results of previous environmental investigations identified the pit as a significant contributor to the degradation of groundwater in the area.

In July of 1995, a source removal action was initiated at Ryan's Pit which included the excavation and treatment of VOC contaminated soil. Approximately 180 cubic yards of contaminated soils and debris were excavated and placed in nine roll-off containers (RMRS, 1996). An additional roll-off container was filled with topsoil scraped off the surface prior to the start of excavation activities. These soils were treated using a low temperature thermal desorption unit. The removal action was conducted prior to the implementation of RFCA, however, the treated soils were below RFCA Tier II action levels for radionuclides and below programmatic risk-based preliminary remediation goals (PPRGs) which were based on the construction worker, subsurface soil scenario.

4.0 SOIL REMEDIATION VOLUME ESTIMATE

All available surface soil contamination data were compared against RFCA Tier I soil action levels for the Buffer Zone (hypothetical resident) to establish an estimate on the areal extent of remaining contaminated soils requiring remediation. This scenario assumes an annual radiation dose of 85 millirem (mrem). Table 3-1 provides the Tier I action levels for the Buffer Zone hypothetical resident scenario. Figure 3-9 and 3-10 identify those areas that exceed the Tier I action levels.

4.1 903 Pad Drum Storage Site

It is anticipated that the 903 Pad Drum Storage Site will be remediated to prevent potential future surface erosion and transport of contaminated soils from beneath the pad. The volume of contaminated soil beneath the 903 Pad, as well as the volume of the asphalt pad itself, were estimated. During initial remedial actions at the 903 Pad Drum Storage Site, approximately 20 cm of clean fill and a layer of asphalt were placed over contaminated soils. Although the 20 cm of fill may not be entirely contaminated, the entire volume is suspect and will require screening if excavated. In addition, data collected beneath the 903 Pad indicate radionuclide contamination above 250 dpm to a depth of 66 cm. Assuming an excavation depth of 66 cm (26 in), the volume of radionuclide contaminated soil material to be remediated from beneath the 903 Pad (asphalt) is estimated at 11,880 cubic yards. This estimate is based on excavating soil materials beneath the cap (3.4 acres) to a depth of 66 cm (26 in).

The volume of VOC contaminated soil requiring remediation beneath the 903 Pad is estimated at 13,300 cubic yards. This volume is based on data from groundwater monitoring wells, and is estimated as an area 235 feet long, 85 feet wide, and 20 feet deep requiring treatment. The volume calculation excludes the top 2 feet of material.

Assuming an asphalt thickness of 3 inches and a surface area of 3.4 acres, 1,370 cubic yards of asphalt pad will require disposal. The total estimated volume of soil and asphalt material requiring remediation within the 903 Pad area is 26,550 yd^3 (Table 4-1).

TABLE 4-1
VOLUME OF *IN SITU* SOIL/ASPHALT
EXCEEDING RFCA TIER I ACTION LEVELS

Location	Surface Area Requiring Remediation (acres)	VOC-Contaminated Soil Requiring Remediation (yd^3)	Radionuclide-Contaminated Soil Requiring Remediation (yd^3)	Total (yd^3)
903 Pad (Asphalt)	3.4	0	1,370	1,370
903 Pad (Soils)	3.4	13,300	11,880	25,180
903 Lip Area	4.4	0	7,100	7,100
Non-IHSS Locations	8.1	0	13,068	13,068
Grand Total	15.9	13,300	33,418	**46,718**

4.2 903 Lip Area

Within the 903 Lip Area, approximately 4.4 acres require remediation based upon the Tier I action levels for the Buffer Zone. CDH sampling results for Plot 28 (2.5 acres) exceeded Tier I action levels. Seventy-five percent (1.9 acres) of Plot 29 lies within the 903 Lip Area. Plot 29 was identified as exceeding Tier I action levels for radionuclides from RF sampling method results. Further field screening would be required to further refine the volume of soils requiring remediation. For the purposes of this summary it was assumed that the entire plot exceeded the Tier I action level and requires remedial action.

During initial remedial actions at the 903 Lip Area, an undetermined amount of imported base coarse material was placed over contaminated surface soils. In an effort to determine the depth of the fill material, soil profile descriptions from soil profile pits TR06, TR07, and TR08 were examined. These pits were excavated in the 903 Lip Area. Based on the profile data, there is .8 to 5" of fill material present in the 903 Lip Area. The log of TR06 indicated that the A soil horizon, 0-2 cm (0.8 in) was deposited as part of the remedial activities in 1969. The C horizon is described as a loose sandy loam and is interpreted to be natural soils. The log describing TR07 soils states that the topsoil was removed and backfilled with a sandy material. The log describes the A soil horizon, 0-2 cm (0-0.8 in), and C soil horizon, 2-13 cm (0.8-5.1 in.) as loose sand. This sand is interpreted to represent fill which is present to a depth of 5 inches at this location.

Logs from TR08 describe the first 16 cm (6.3 in) as a loose sand, typical of the fill material. Soil profile sampling locations are provided on Figure 3-12.

The CDH and RF soil sampling methods collect samples 0.64 inches and 2 inches in depth, respectively. Surficial soil samples previously collected within the 903 Lip Area were composed of the fill material used to cover the contaminated soil surface, leaving the contaminated surface uncharacterized. However, fill materials at TR08 have been contaminated by radionuclides based on the fact the top 27 cm (11 in) of soil, which includes the fill material, exceed Tier I action levels at this location. The fill material may have been contaminated by winds blowing contaminated soils back toward the pad from adjacent Plot 34 or by reworking of soils. Plot 34 was identified as exceeding Tier I action levels based on the OU 2 CDH sampling program.

The results of the soil investigations indicate that outside the 903 Pad Drum Storage Site, over 90 percent of the plutonium-239/240 and americium-241 contamination is confined to the upper 15 cm (6 in) of soils. Soil sample results at soil profile pit TR08, located in the 903 Lip Area, indicate the depth of contamination above Tier I action levels from the ground surface to 27 cm (11 in). Numerous large cobbles and small boulders are present in the Rocky Flats Alluvium and excavation of surface soils is expected to be difficult. Therefore, a 12 in (1 ft) excavation depth was assumed as the extent to which soils will be remediated. Using this excavation depth, an estimated total volume of 7,100 cubic yards of contaminated surface soils would require remediation for the 4.4 acres exceeding the action level.

4.3 Non-IHSS Locations

A total of 8.1 acres have been preliminarily identified outside the 903 Pad and 903 Lip Area requiring remediation. CDH sampling results for Plot 34 exceed Tier I action levels. The RF sampling method results identified Plots 46 and 36 as exceeding Tier I action levels. Twenty-five percent (0.63 acres) of Plot 29 lies within the 903 Pad Source Area-Non IHSS Location. As discussed above, the fact that the Rocky Flats sampling methodology only addressed a 3 square meter plot within the 2.5-acre plots. Therefore, further field screening would be required to refine the volume of soil requiring remediation. For the purposes of this document it was assumed that the entire plot exceeded the Tier I action level and requires remedial action. Assuming a 12 in depth for the excavation, a total of 13,068 cubic yards of material will be excavated from the area.

The total estimated volume of contaminated surface soil requiring remediation is 46,718 cubic yards. This volume estimate was rounded up to 47,000 cubic yards for use in the evaluation of remediation process options and alternatives. Table 4-1 presents the location and volumes of soils requiring remediation.

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903 DRUM STORAGE SITE,
903 LIP AREA, AND
NON-IHSS AREA
DATA SUMMARY

TABLES

(Tables 2.1, 2.2, 2.3, 2.5,2.7, 2.8, and 3.1)

TABLE 3-2
SURFACE SOILS OU 2 PHASE II RFI/RI
CDH SAMPLING METHOD
RFCA TIER I SUM OF RATIO COMPARISON- RADIONUCLIDES

LOCATION	AM241 (pCi/g)	PU239/240 (pCi/g)	U233/234 (pCi/g)	U235 (pCi/g)	U238 (pCi/g)	Sum of Ratios
PT000	0.0913	0.4728	1.0240	0.0128	1.0520	0.0032
PT001	0.0692	0.4682	1.3700	0.0663	1.3780	0.0043
PT002	NS	NS	NS	NS	NS	
PT003	0.2298	1.3100	1.3380	0.0640	1.1650	0.0052
PT004	0.1217	0.7238	1.1380	0.0263	0.9698	0.0036
PT005	0.0710	0.2900	1.2000	0.0750	1.4000	0.0042
PT006	0.1840	0.9090	1.0500	0.0500	4.9600	0.0109
PT007	NS	NS	NS	NS	NS	
PT008	NS	NS	NS	NS	NS	
PT009	NS	NS	NS	NS	NS	
PT010	0.6183	3.8830	1.0980	0.0322	1.2300	0.0086
PT011	0.0643	0.4517	0.8288	0.0356	0.9932	0.0031
PT012	0.0870	0.3970	1.1000	0.0920	1.2000	0.0040
PT013	0.1100	0.1870	0.8100	0.0200	1.0900	0.0031
PT014	NS	NS	NS	NS	NS	
PT015	2.2550	11.6400	1.4140	0.0520	1.4120	0.0222
PT016	6.0650	46.7170	2.0900	0.0900	7.7400	0.0760
PT017	NS	NS	NS	NS	NS	
PT018	NS	NS	NS	NS	NS	
PT019	12.5100	81.6500	1.2230	0.0802	1.6220	0.1194
PT020	35.3280	118.8550	2.9900	0.2800	3.3000	0.2569
PT021	19.3220	64.9660	1.7100	0.1300	2.1400	0.1409
PT022	1.8550	15.1600	1.4750	0.0518	1.3340	0.0227
PT023	0.2567	1.7180	1.0140	0.0524	1.0050	0.0051
PT024	0.1220	1.2370	1.3000	0.2000	1.5000	0.0062
PT025	0.2710	1.2590	1.3000	0.0260	1.6000	0.0058
PT026	1.3550	5.7320	1.2600	0.0400	1.5200	0.0139
PT027	9.3690	52.3900	2.0600	0.0800	3.9300	0.0887
PT028	**270.4000**	**1453.0000**	**2.4660**	**0.1794**	**7.2550**	**2.2896**
PT029	89.5100	507.6000	1.3380	0.0988	1.9830	0.7764
PT030	27.6600	167.1000	1.1270	0.0432	1.5870	0.2493
PT031	3.4140	23.3900	1.1030	0.0713	1.2050	0.0355
PT032	5.5560	22.9710	2.1700	0.1100	2.4600	0.0482
PT033	15.8200	138.8330	1.8000	0.2300	1.9400	0.1768
PT034	**164.1000**	**961.6000**	**0.9941**	**0.0728**	**2.2320**	**1.4411**
PT035	66.3000	296.6000	1.4420	0.0695	1.8310	0.5204
PT036	14.7360	95.8330	2.2600	0.1600	1.5500	0.1407
PT037	3.8560	27.2680	1.6400	0.0500	1.8800	0.0415
PT038	0.6400	3.7880	1.2000	0.0990	1.2000	0.0091
PT039	0.2830	1.3910	1.3000	0.0270	1.3000	0.0055
PT040	0.1500	0.7910	1.3000	0.0310	1.5000	0.0048
PT041	0.1430	0.7480	1.4000	0.0910	1.2000	0.0047

LOCATION	AM241 (pCi/g)	PU239/240 (pCi/g)	U233/234 (pCi/g)	U235 (pCi/g)	U238 (pCi/g)	Sum of Ratios
PT042	0.2040	0.3360	1.4000	0.0300	1.2000	0.0043
PT043	0.1320	0.5090	1.1000	0.0590	1.2000	0.0041
PT044	5.8400	21.9250	3.4400	0.1900	2.5400	0.0502
PT045	26.3400	154.3000	1.2530	0.0656	1.8450	0.2348
PT046	54.1800	294.2000	1.1020	0.0592	1.5240	0.4616
PT047	25.5500	160.5000	1.0610	0.1059	1.2890	0.2347
PT048	9.4980	123.8	1.1750	0.1028	1.7740	0.1353
PT049	4.6810	191.1	0.8448	0.0332	1.2420	0.1584
PT050	0.1920	0.3860	1.2000	0.1600	1.3000	0.0053
PT051	0.1840	0.7470	1.3000	0.0970	1.2000	0.0049
PT052	1.4220	7.3370	2.8000	0.0770	1.7000	0.0168
PT053	6.8350	61.3710	2.2400	0.1700	2.1400	0.0809
PT054	20.9160	169.5270	1.4900	0.0700	1.9200	0.2206
PT055	11.9980	82.8590	1.1000	0.1000	1.8000	0.1182
PT056	5.0640	19.1770	2.3000	0.3600	1.7000	0.0439
PT057	1.1130	7.1870	1.1790	0.0472	1.1190	0.0131
PT058	0.8770	5.0150	1.6000	0.3800	1.3000	0.0135
PT059	0.2200	1.6570	1.3000	0.0540	1.3000	0.0055
PT060	0.0970	0.4120	1.3000	0.0310	1.2000	0.0038
PT061	4.6130	19.8560	1.8600	0.0700	2.2600	0.0408
PT062	15.3990	98.3490	2.4100	0.1300	2.4700	0.1470
PT063	0.0690	0.5200	1.3000	0.1200	1.2000	0.0044
PT064	0.2660	0.6390	1.0000	0.0760	1.1000	0.0047
PT065	3.7030	7.5080	1.2000	0.0980	1.5000	0.0265
PT066	5.9550	29.2570	2.0500	0.1100	2.6400	0.0547
PT067	13.5320	101.6460	2.5600	0.0900	2.5800	0.1406
PT068	3.2120	24.8740	3.4000	0.6800	2.3000	0.0433
PT069	0.9730	7.8710	0.9900	0.0340	2.2000	0.0146
PT070	0.5010	3.2200	2.0000	0.0990	1.7000	0.0094
PT071	0.0870	0.5870	1.5000	0.1600	0.9900	0.0046
PT072	5.9390	26.1000	1.5000	0.0410	1.9000	0.0503
PT073	2.1690	13.9700	2.2000	0.2200	2.1000	0.0263
PT074	2.2490	10.4930	1.5000	0.1100	1.4000	0.0219
PT075	0.1856	1.1650	1.2610	0.0909	1.1170	0.0050
PT076	0.4890	2.5380	1.1760	0.0302	1.1320	0.0069
PT077	1.2020	8.9720	3.5810	0.1504	1.0830	0.0169
PT078	2.9130	26.1100	1.2790	0.0972	1.8870	0.0365
PT079	5.2960	24.5150	2.2000	0.4300	1.7000	0.0491
PT080	2.0910	11.7970	1.4000	0.0660	1.3000	0.0215
PT081	Rejected	3.4420	1.0370	0.0663	1.1130	0.0054
PT082	0.6418	5.5550	1.1030	0.0156	1.1160	0.0095
PT083	0.2640	1.5210	1.2940	0.0341	1.4210	0.0057
PT084	0.4346	2.1220	1.0370	0.0376	1.0370	0.0062
PT085	0.6212	4.1960	1.1430	0.0389	1.1410	0.0087
PT086	1.7030	7.1500	0.9243	0.0313	1.2060	0.0157
PT087	1.7730	12.4300	1.2410	0.0398	1.1080	0.0198
PT088	3.5380	18.5100	1.4000	0.0266	1.3830	0.0328
PT089	0.3853	2.3660	1.3370	0.0765	1.6110	0.0075
PT090	0.1594	1.1010	1.2540	0.0627	1.2090	0.0048

LOCATION	AM241 (pCi/g)	PU239/240 (pCi/g)	U233/234 (pCi/g)	U235 (pCi/g)	U238 (pCi/g)	Sum of Ratios
PT091	0.0159	0.0751	0.8912	0.0083	1.2090	0.0028
PT092	0.5346	2.8320	1.3300	0.0218	1.2100	0.0075
PT093	0.8739	6.6090	1.0440	0.0318	1.0090	0.0112
PT094	3.3610	17.1800	1.1470	0.0666	1.1370	0.0307
PT095	1.3240	8.4290	1.2380	0.0324	1.3010	0.0152
PT096	0.4944	3.1210	1.3010	0.0790	1.3700	0.0082
PT097	0.2409	1.5810	1.4170	0.0384	1.2770	0.0055
PT098	0.0232	0.1822	1.1010	0.0160	0.9214	0.0026
PT099	0.0152	0.0751	0.8166	0.0064	1.0490	0.0024
PT100	0.6133	5.8870	Rejected	Rejected	Rejected	0.0070
PT101	0.5262	2.1980	0.9717	0.0287	0.9831	0.0064
PT102	0.5983	3.1130	1.0830	0.0229	1.0200	0.0075
PT103	0.0714	0.4467	1.0750	0.0196	0.9922	0.0031
PT104	2.5260	2.2410	1.3990	0.0123	1.3080	0.0164
PT105	0.5423	2.2990	0.9937	0.0099	1.0530	0.0066
PT106	2.3790	11.5000	1.2230	0.0560	1.2230	0.0223
PT107	1.0720	6.6670	0.8586	0.0356	0.9161	0.0120
PT108	0.3588	1.7450	1.2080	0.0408	1.4610	0.0064
PT109	0.2153	1.3690	1.0800	0.0457	1.1430	0.0049
PT110	0.9958	7.2810	1.0000	0.0247	0.8337	0.0119
PT111	0.0053	0.0484	1.0340	0.0458	1.0730	0.0028
PT112	0.1936	1.2450	0.8736	0.0177	0.8905	0.0039
PT113	0.5409	3.4850	1.1330	0.0206	1.0650	0.0076
PT114	1.3010	8.9330	1.2540	0.0449	1.1200	0.0153
PT115	0.1312	0.8546	1.0570	0.0384	1.1970	0.0041
PT116	0.0435	0.1194	0.9250	0.0190	1.0930	0.0028
PT117	0.0285	0.0833	1.0810	0.0713	1.0190	0.0031
PT118	0.0926	0.5577	0.9724	0.0569	0.9224	0.0034
PT119	0.4747	2.3580	1.1940	0.0538	0.9829	0.0066
PT120	0.3811	12.8400	0.8758	0.0286	1.1780	0.0135
PT121	0.8226	4.4370	1.2460	-0.0037	1.0120	0.0093
PT122	0.2625	2.2290	1.0830	0.1244	1.1420	0.0063
PT123	0.2151	1.0540	0.9344	0.0200	1.3690	0.0048
PT124	0.0474	0.1821	0.7295	0.0789	0.9092	0.0029

NS Not Sampled.
Rejected Data validated as rejected.

TABLE 3-3

OU 2 PHASE II RFI/RI

SURFACE SOILS - RF SAMPLING METHOD
RFCA TIER I SUM OF RATIO COMPARISON- RADIONUCLIDES

LOCATION	AM241 (pCi/g)	PU239/240 (pCi/g)	Sum of Ratios
PT000	ND	ND	
PT001	0.0390	0.0730	0.0002
PT002	NS	NS	
PT003	0.5345	2.2410	0.0041
PT004	0.1394	0.3491	0.0009
PT005	0.0740	0.2430	0.0005
PT006	NS	NS	
PT007	NS	NS	
PT008	NS	NS	
PT009	0.7393	5.4710	0.0073
PT010	0.6870	3.8310	0.0059
PT011	0.0580	0.2700	0.0005
PT012	0.1183	Rejected	0.0006
PT013	ND	ND	
PT014	NS	NS	
PT015	Rejected	18.9400	0.0133
PT016	2.0690	21.1600	0.0244
PT017	NS	NS	
PT018	NS	NS	
PT019	22.0000	120.0000	0.1863
PT020	3.4000	23.0000	0.0319
PT021	10.5300	59.6300	0.0907
PT022	3.8340	36.7800	0.0436
PT023	0.1460	1.7760	0.0019
PT024	0.1545	0.8933	0.0013
PT025	0.2454	1.4160	0.0021
PT026	ND	ND	
PT027	ND	ND	
PT028	Rejected	380.0000	0.2659
PT028	110.0000	Rejected	0.5116
PT029	160.0000	950.0000	**1.4090**
PT030	38.0000	280.0000	0.3727
PT031	0.6419	4.7660	0.0063
PT032	10.5500	44.7150	0.0804
PT033	ND	ND	
PT034	Rejected	Rejected	
PT035	26.0000	380.0000	0.3869
PT036	34.0000	5700.0000	**4.1469**
PT037	3.9680	17.6200	0.0308
PT038	0.0870	0.6100	0.0008
PT039	0.1035	0.6869	0.0010
PT040	0.0466	0.3520	0.0005
PT041	0.0670	0.5780	0.0007

LOCATION	AM241 (pCi/g)	PU239/240 (pCi/g)	Sum of Ratios
PT042	ND	ND	
PT043	ND	ND	
PT044	ND	ND	
PT045	Rejected	260.0000	0.1819
PT046	Rejected	7300.0000	**5.1085**
PT047	ND	ND	
PT048	ND	ND	
PT049	Rejected	29.0000	0.0203
PT050	0.0815	0.2110	0.0005
PT051	0.1297	0.5325	0.0010
PT052	1.2980	5.9450	0.0102
PT053	4.1540	19.9900	0.0333
PT054	Rejected	120.0000	0.0840
PT055	Rejected	200.0000	0.1400
PT056	Rejected	6.4000	0.0045
PT057	0.6135	4.4350	0.0060
PT058	0.4869	4.3920	0.0053
PT059	0.2760	0.9890	0.0020
PT060	0.0733	0.4237	0.0006
PT061	Rejected	2.7000	0.0019
PT062	NS	NS	
PT063	0.0738	0.1960	0.0005
PT064	0.2702	Rejected	0.0013
PT065	0.1949	1.3850	0.0019
PT066	54.0000	57.0000	0.2911
PT067	Rejected	47.7800	0.0334
PT068	4.3000	23.0000	0.0361
PT069	0.9680	12.1780	0.0130
PT070	0.4092	2.4610	0.0036
PT071	0.1400	0.4520	0.0010
PT072	2.0690	11.5800	0.0177
PT073	Rejected	31.0000	0.0217
PT074	2.1540	10.8400	0.0176
PT075	0.1647	1.3990	0.0017
PT076	0.3599	1.6370	0.0028
PT077	0.8293	5.4980	0.0077
PT078	5.2880	29.1750	0.0450
PT079	3.7100	22.9600	0.0333
PT080	1.6610	8.7360	0.0138
PT081	0.8440	5.9960	0.0081
PT082	0.4740	3.4840	0.0046
PT083	0.1750	1.4270	0.0018
PT084	0.3089	1.5790	0.0025
PT085	0.8996	3.3510	0.0065
PT086	0.9303	8.7430	0.0104
PT087	2.0730	10.2950	0.0168
PT088	3.1350	20.3440	0.0288
PT089	ND	ND	
PT090	0.3166	2.0810	0.0029

LOCATION	AM241 (pCi/g)	PU239/240 (pCi/g)	Sum of Ratios
PT091	0.0542	0.2664	0.0004
PT092	0.3051	2.1210	0.0029
PT093	1.2710	6.8990	0.0107
PT094	2.9240	13.8120	0.0233
PT095	0.8649	5.0620	0.0076
PT096	0.3733	8.4480	0.0076
PT097	Rejected	2.5070	0.0018
PT098	0.0440	0.1980	0.0003
PT099	0.0850	0.0960	0.0005
PT100	1.5700	0.7760	0.0078
PT101	0.5694	2.3150	0.0043
PT102	3.1030	50.3000	0.0496
PT103	0.1100	0.2310	0.0007
PT104	0.4717	2.9390	0.0043
PT105	0.2401	1.8210	0.0024
PT106	2.3260	11.7010	0.0190
PT107	0.5259	3.1380	0.0046
PT108	0.3790	2.7090	0.0037
PT109	0.2255	1.4550	0.0021
PT110	0.3090	1.5020	0.0025
PT111	0.0110	0.0440	0.0001
PT112	0.4920	1.5420	0.0034
PT113	1.4570	5.7970	0.0108
PT114	0.7478	4.4720	0.0066
PT115	0.0862	0.6100	0.0008
PT116	0.0450	0.2740	0.0004
PT117	0.0391	0.2504	0.0004
PT118	Rejected	0.6567	0.0005
PT119	0.3004	1.7080	0.0026
PT120	0.9913	7.1980	0.0096
PT121	0.5877	2.6130	0.0046
PT122	0.3948	2.2620	0.0034
PT123	0.1201	0.9148	0.0012
PT124	0.0329	0.2820	0.0004

NS Not Sampled
ND No Data

TABLE 3-4

SOIL PROFILE PITS 1-26
TRENCH SAMPLING METHOD
OPERABLE UNIT NO.2 PHASE II RFI/RI
RFCA TIER I SUM OF RATIO COMPARISON - RADIONUCLIDES

Location	Sample Number	Sum of Ratios
TR01	TR00341WCU2	0.0030
TR01	TR00342WCU2	0.0032
TR01	TR00343WCU2	0.0027
TR01	TR00344WCU2	0.0035
TR01	TR00345WCU2	0.0050
TR01	TR00346WCU2	0.0121
TR01	TR00347WCU2	0.0294
TR01	TR00348WCU2	0.1129
TR01	TR00349WCU2	0.1312
TR01	TR00350WCU2	0.1681
TR02	TR00393WCU2	0.0030
TR02	TR00395WCU2	0.0023
TR02	TR00396WCU2	0.0021
TR02	TR00397WCU2	0.0039
TR02	TR00399WCU2	0.0160
TR02	TR00400WCU2	0.0679
TR02	TR00401WCU2	0.0904
TR02	TR00402WCU2	0.1744
TR02	TR00403WCU2	0.3549
TR02	TR00404WCU2	0.3339
TR03	TR00372WCU2	0.0032
TR03	TR00373WCU2	0.0024
TR03	TR00374WCU2	0.0029
TR03	TR00375WCU2	0.0049
TR03	TR00376WCU2	0.0116
TR03	TR00377WCU2	0.0125
TR03	TR00378WCU2	0.3595
TR03	TR00379WCU2	0.3521
TR03	TR00380WCU2	0.4124
TR03	TR00381WCU2	0.2253
TR03	TR00386WCU2	0.0037
TR03	TR00389WCU2	0.0034
TR03	TR00390WCU2	0.0031
TR04	TR00413WCU2	0.0015
TR04	TR00414WCU2	0.0032
TR04	TR00415WCU2	0.0035
TR04	TR00416WCU2	0.0035
TR04	TR00417WCU2	0.0071
TR04	TR00418WCU2	0.0129
TR04	TR00419WCU2	0.1367
TR04	TR00420WCU2	0.4517
TR04	TR00421WCU2	0.6219
TR04	TR00422WCU2	0.8893

Location	Sample Number	Sum of Ratios
TR04	TR00431WCU2	0.0035
TR05	TR00358WCU2	0.0016
TR05	TR00359WCU2	0.0018
TR05	TR00360WCU2	0.0046
TR05	TR00361WCU2	0.0392
TR05	TR00362WCU2	0.0395
TR05	TR00363WCU2	0.1407
TR05	TR00364WCU2	0.2118
TR05	TR00365WCU2	0.4376
TR05	TR00366WCU2	0.4295
TR05	TR00367WCU2	0.7886
TR06	Samples Not Analyzed	
TR07	TR00307WCU2	0.0015
TR07	TR00308WCU2	0.0031
TR07	TR00309WCU2	0.0028
TR07	TR00310WCU2	0.0067
TR07	TR00311WCU2	0.0105
TR07	TR00312WCU2	0.0323
TR07	TR00313WCU2	0.2907
TR07	TR00314WCU2	0.0365
TR07	TR00315WCU2	0.0514
TR07	TR00316WCU2	0.0288
TR08	TR00323WCU2	0.0099
TR08	TR00324WCU2	0.0013
TR08	TR00325WCU2	0.0165
TR08	TR00326WCU2	0.4119
TR08	**TR00327WCU2**	**2.2325**
TR08	**TR00328WCU2**	**2.0584**
TR08	**TR00329WCU2**	**7.6719**
TR08	**TR00330WCU2**	**3.2540**
TR08	**TR00331WCU2**	**3.2948**
TR08	**TR00332WCU2**	**7.7843**
TR09	TR00291WCU2	0.0037
TR09	TR00292WCU2	0.0021
TR09	TR00293WCU2	0.0033
TR09	TR00294WCU2	0.0031
TR09	TR00295WCU2	0.0057
TR09	TR00296WCU2	0.0141
TR09	TR00297WCU2	0.0441
TR09	TR00298WCU2	0.0966
TR09	TR00299WCU2	0.2510
TR09	TR00300WCU2	0.2513
TR10	TR00171WCU2	0.0022
TR10	TR00172WCU2	0.0028
TR10	TR00173WCU2	0.0030
TR10	TR00174WCU2	0.0037
TR10	TR00175WCU2	0.0017
TR10	TR00176WCU2	0.0025
TR10	TR00177WCU2	0.0035
TR10	TR00178WCU2	0.0056

Location	Sample Number	Sum of Ratios
TR10	TR00179WCU2	0.0062
TR10	TR00180WCU2	0.0343
TR10	TR00181WCU2	0.0569
TR11	TR00274WCU2	0.0027
TR11	TR00275WCU2	0.0031
TR11	TR00276WCU2	0.0023
TR11	TR00277WCU2	0.0034
TR11	TR00278WCU2	0.0037
TR11	TR00279WCU2	0.0051
TR11	TR00280WCU2	0.0050
TR11	TR00281WCU2	0.0171
TR11	TR00282WCU2	0.0289
TR11	TR00283WCU2	0.0813
TR11	TR00284WCU2	0.1386
TR12	TR00256WCU2	0.0042
TR12	TR00257WCU2	0.0026
TR12	TR00258WCU2	0.0023
TR12	TR00260WCU2	0.0023
TR12	TR00262WCU2	0.0024
TR12	TR00263WCU2	0.0089
TR12	TR00264WCU2	0.0428
TR12	TR00265WCU2	0.0504
TR12	TR00266WCU2	0.1311
TR12	TR00267WCU2	0.5773
TR13	TR00104WCU2	0.0027
TR13	TR00105WCU2	0.0021
TR13	TR00106WCU2	0.0026
TR13	TR00107WCU2	0.0011
TR13	TR00108WCU2	0.0016
TR13	TR00109WCU2	0.0021
TR13	TR00110WCU2	0.0027
TR13	TR00111WCU2	0.0036
TR13	TR00112WCU2	0.0060
TR13	TR00113WCU2	0.0100
TR14	TR00239WCU2	0.0016
TR14	TR00240WCU2	0.0016
TR14	TR00241WCU2	0.0010
TR14	TR00242WCU2	0.0008
TR14	TR00243WCU2	0.0042
TR14	TR00244WCU2	0.0056
TR14	TR00245WCU2	0.0074
TR14	TR00246WCU2	0.0084
TR14	TR00247WCU2	0.0111
TR14	TR00248WCU2	0.0291
TR15	TR00122WCU2	0.0167
TR15	TR00123WCU2	0.0030
TR15	TR00124WCU2	0.0025
TR15	TR00125WCU2	0.0014
TR15	TR00126WCU2	0.0005
TR15	TR00127WCU2	0.0026

Location	Sample Number	Sum of Ratios
TR15	TR00128WCU2	0.0045
TR15	TR00129WCU2	0.0053
TR15	TR00130WCU2	0.0036
TR15	TR00131WCU2	0.0116
TR16	TR00071WCU2	0.0025
TR16	TR00072WCU2	0.0031
TR16	TR00073WCU2	0.0029
TR16	TR00074WCU2	0.0020
TR16	TR00075WCU2	0.0050
TR16	TR00076WCU2	0.0041
TR16	TR00077WCU2	0.0065
TR16	TR00078WCU2	0.0066
TR16	TR00079WCU2	0.0093
TR16	TR00080WCU2	0.0109
TR17	TR00155WCU2	0.0062
TR17	TR00156WCU2	0.0044
TR17	TR00157WCU2	0.0029
TR17	TR00158WCU2	0.0058
TR17	TR00159WCU2	0.0086
TR17	TR00160WCU2	0.0056
TR17	TR00161WCU2	0.0061
TR17	TR00162WCU2	0.0082
TR17	TR00163WCU2	0.0346
TR17	TR00164WCU2	0.1604
TR18	TR00086WCU2	0.0066
TR18	TR00087WCU2	0.0098
TR18	TR00088WCU2	0.0130
TR18	TR00089WCU2	0.0069
TR18	TR00090WCU2	0.0080
TR18	TR00091WCU2	0.0093
TR18	TR00092WCU2	0.0094
TR18	TR00093WCU2	0.0055
TR18	TR00094WCU2	0.0092
TR18	TR00095WCU2	0.0197
TR19	TR00139WCU2	0.0116
TR19	TR00140WCU2	0.0081
TR19	TR00141WCU2	0.0065
TR19	TR00142WCU2	0.0083
TR19	TR00143WCU2	0.0075
TR19	TR00144WCU2	0.0091
TR19	TR00145WCU2	0.0062
TR19	TR00146WCU2	0.0122
TR19	TR00147WCU2	0.0134
TR19	TR00148WCU2	0.0135
TR20	TR00051WCU2	0.0141
TR20	TR00052WCU2	0.0053
TR20	TR00053WCU2	0.0193
TR20	TR00054WCU2	0.0027
TR20	TR00055WCU2	0.0045
TR20	TR00056WCU2	0.0072

Location	Sample Number	Sum of Ratios
TR20	TR00057WCU2	0.0050
TR20	TR00058WCU2	0.0059
TR20	TR00059WCU2	0.0091
TR20	TR00060WCU2	0.0095
TR21	TR00001WCU2	0.0029
TR21	TR00002WCU2	0.2006
TR21	TR00003WCU2	0.4591
TR21	TR00004WCU2	0.0029
TR21	TR00005WCU2	0.0027
TR21	TR00006WCU2	0.0032
TR21	TR00007WCU2	0.0028
TR21	TR00008WCU2	0.0036
TR21	TR00009WCU2	0.0037
TR21	TR00010WCU2	0.0095
TR22	TR00016WCU2	0.0044
TR22	TR00017WCU2	0.0032
TR22	TR00018WCU2	0.0011
TR22	TR00019WCU2	0.0027
TR22	TR00020WCU2	0.0007
TR22	TR00021WCU2	0.0032
TR22	TR00022WCU2	0.0041
TR22	TR00023WCU2	0.0085
TR22	TR00024WCU2	0.0031
TR22	TR00025WCU2	0.0102
TR22	TR00026WCU2	0.0061
TR23	TR00034WCU2	0.0043
TR23	TR00035WCU2	0.0044
TR23	TR00036WCU2	0.0389
TR23	TR00037WCU2	0.0299
TR23	TR00038WCU2	0.0093
TR23	TR00039WCU2	0.0059
TR23	TR00041WCU2	0.0102
TR23	TR00042WCU2	0.0084
TR23	TR00043WCU2	0.0028
TR23	TR00044WCU2	0.0031
TR23	TR00050WCU2	0.0048
TR24	TR00189WCU2	0.0024
TR24	TR00190WCU2	0.0018
TR24	TR00191WCU2	0.0016
TR24	TR00192WCU2	0.0031
TR24	TR00193WCU2	0.0031
TR24	TR00194WCU2	0.0037
TR24	TR00195WCU2	0.0037
TR24	TR00196WCU2	0.0051
TR24	TR00197WCU2	0.0048
TR24	TR00206WCU2	0.0022
TR25	TR00223WCU2	0.0058
TR25	TR00224WCU2	0.0077
TR25	TR00225WCU2	0.0096
TR25	TR00226WCU2	0.0108

Location	Sample Number	Sum of Ratios
TR25	TR00227WCU2	0.0115
TR25	TR00228WCU2	0.0117
TR25	TR00229WCU2	0.0135
TR25	TR00230WCU2	0.0119
TR25	TR00231WCU2	0.0153
TR25	TR00233WCU2	0.0157
TR26	TR00207WCU2	0.0066
TR26	TR00208WCU2	0.0096
TR26	TR00209WCU2	0.0105
TR26	TR00210WCU2	0.0101
TR26	TR00211WCU2	0.0069
TR26	TR00212WCU2	0.0124
TR26	TR00213WCU2	0.0152
TR26	TR00214WCU2	0.0150
TR26	TR00215WCU2	0.0170
TR26	TR00216WCU2	0.0190

Trench TR06 was sampled but not analyzed because activity exceeded DOT shipping requirements.

TABLE 3-6

SURFACE SOILS
OU 1 PHASE III RFI/RI
RFCA TIER I SUM OF RATIO COMPARISON- RADIONUCLIDES

LOCATION	AM241 (pCi/g)	PU239/240 (pCi/g)	U233/234 (pCi/g)	U235 (pCi/g)	U238 (pCi/g)	Sum of Ratios
RA010	0.2300	2.4920	1.0860	0.0750	1.1960	0.01
RA011	Rejected	1.0630	0.8350	0.0176	0.7136	0.00
RA011	Rejected	1.1750	0.7814	0.0523	0.9987	0.00
RA012	0.0129	0.0677	1.1480	0.0584	1.0280	0.00
RA013	0.1240	0.6600	0.7370	0.0610	0.9000	0.00
RA014	0.0390	0.1050	0.9720	0.1040	0.8500	0.00
RA015	Rejected	0.2249	1.5300	0.0406	1.5680	0.00
RA015	Rejected	1.3090	1.2620	0.0791	1.3650	0.00
RA016	0.1440	0.5830	0.6780	0.0330	0.7640	0.00
RA017	Rejected	0.5944	0.7611	0.0570	0.8466	0.00
RA018	0.4900	3.0020	1.2500	0.0530	1.1830	0.01
RA019	0.2627	1.5530	1.1600	0.0243	1.1690	0.01
RA020	0.1917	0.9275	0.9581	0.0790	0.9509	0.00
RA021	Rejected	0.4165	1.6620	0.0340	1.7690	0.00
RA022	0.2849	2.0890	1.2870	0.0905	1.4790	0.01
RA023	1.1480	7.0840	1.4620	0.0808	1.5710	0.01
RA024	1.6720	11.0800	1.6020	0.0390	1.7320	0.02
RA025	1.9440	12.9900	1.4900	-0.0060	1.4480	0.02
RA026	0.1200	1.0430	1.0450	0.0330	1.3190	0.00
RA027	0.6640	9.6950	1.1920	0.0290	1.1800	0.01
RA028	0.0137	0.0907	1.2960	0.0086	1.5020	0.00
RA029	0.4420	2.3850	1.2660	0.0530	1.1290	0.01
RA030	0.2470	1.0030	1.2340	0.0300	0.9400	0.00
RA031	0.5370	3.0440	1.2150	0.0580	1.5800	0.01
RA031	0.7160	5.8590	0.9730	0.0870	1.4180	0.01
RA032	0.1280	0.7350	1.0560	0.0380	1.3190	0.00
RA032	0.0950	0.5270	1.2540	0.0840	1.2890	0.00
RA033	0.0970	0.6720	1.2280	0.1220	2.1990	0.01
RA033	0.0770	0.4000	1.5100	0.0850	1.5100	0.00
RA034	0.7140	1.3420	1.0590	0.0260	1.0120	0.01
RA035	0.1540	0.5950	1.2230	0.0530	1.2850	0.00
RA036	0.0230	0.0980	0.8820	0.0640	0.6260	0.00
RA037	0.0300	0.0950	0.9150	0.1170	0.9770	0.00
RA037	0.0490	0.1150	1.1760	0.0680	1.1760	0.00

Rejected Data Validated as Rejected.

TABLE 3-8

SUBSURFACE SOIL SAMPLES
OPERABLE UNIT NO.2 PHASE I & II RFI/RI
RFCA TIER I SUM OF RATIOS COMPARISON - RADIONUCLIDES

Location	Sample No.	Sum of Ratios
BH2287	BH22870009	0.001
BH2287	BH22871018	0.001
BH2287	BH228710WS	0.001
BH2287	BH228720CT	0.000
BH2287	BH228722BR	0.001
BH2387	BH23870008	0.002
BH2387	BH238708CT	0.001
BH2387	BH238711BR	0.001
BH2487	BH24870002	0.118
BH2487	BH248705CT	0.002
BH2487	BH248708BR	0.002
BH2487	BH248710WS	0.001
BH2687	BH26870003	0.116
BH2687	BH268703CT	0.003
BH2687	BH268706BR	0.002
BH2787	BH27870010	0.005
BH2787	BH278710CT	0.001
BH2787	BH278713BR	0.002
BH2887	BH288700WT	0.006
BH2887	BH28870104	0.002
BH2887	BH288705WS	0.002
BH2887	BH288706CT	0.003
BH2887	BH288709BR	0.006
BH2987	BH29870010	0.002
BH2987	BH298713CT	0.002
BH2987	BH298716BR	0.001
BH2987	BH298717WT	0.001
BH3087	BH30870010	0.230
BH3087	BH30871020	0.001
BH3087	BH308710WS	0.002
BH3087	BH308720WT	0.001
BH3087	BH308725BR	0.001
B315289	5989BR0003	0.019
B315289	5989BR0306	0.002
B315289	5989BR0711	0.001
B315289	5989BR1115	0.002
B315289	5989BR1518	0.001
291	BH00574WCU2	0.017
6591	BH01249WCU2	0.002
6591	BH01251WCU2	0.002
6591	BH01255WCU2	0.002
6591	BH01257WCU2	0.004
6591	BH01260WCU2	0.002
6591	BH01262WCU2	0.002

Location	Sample No.	Sum of Ratios
6591	BH01265WCU2	0.003
6591	BH01268WCU2	0.004
6591	BH01270WCU2	0.002
6691	BH00518WCU2	0.083
6691	BH00520WCU2	0.011
6691	BH00522WCU2	0.003
6691	BH00524WCU2	0.002
6691	BH00525WCU2	0.003
6791	BH00490WCU2	0.003
6791	BH00493WCU2	0.002
6791	BH00496WCU2	0.002
6791	BH00499WCU2	0.003
6791	BH00501WCU2	0.002
6891	BH00540WCU2	0.001
6891	BH00543WCU2	0.002
6991	BH00701WCU2	0.001
6991	BH00702WCU2	0.001
6991	BH00706WCU2	0.002
6991	BH00708WCU2	0.002
6991	BH00710WCU2	0.002
6991	BH00714WCU2	0.003
7091	BH00484WCU2	0.002
7091	BH00486WCU2	0.008
7191	BH00979WCU2	0.002
7191	BH00982WCU2	0.002
7191	BH00985WCU2	0.002
7191	BH00987WCU2	0.003
7291	BH00718WCU2	0.007
7291	BH00719WCU2	0.003
7291	BH00721WCU2	0.003
7291	BH00723WCU2	0.003
7391	BH00475WCU2	0.003
7391	BH00477WCU2	0.004
7391	BH00480WCU2	0.003
7591	BH01227WCU2	0.002
7591	BH01229WCU2	0.058
7491	BH01233WCU2	0.003
7491	BH01235WCU2	0.005
7691	BH01204WCU2	0.003
8691	BH00530WCU2	0.018
8691	BH00533WCU2	0.002
8691	BH00536WCU2	0.003
8691	BH00537WCU2	0.003
8791	BH00505WCU2	0.004
8791	BH00507WCU2	0.002
8791	BH00510WCU2	0.004
8791	BH00512WCU2	0.003
8791	BH00514WCU2	0.002
8891	BH00550WCU2	0.028
8891	BH00552WCU2	0.015

Location	Sample No.	Sum of Ratios
8891	BH00952WCU2	0.004
8891	BH00955WCU2	0.002
8891	BH00957WCU2	0.002
8991	BH00741WCU2	0.018
8991	BH00743WCU2	0.003
8991	BH00745WCU2	0.002
8991	BH00750WCU2	0.002
8991	BH00752WCU2	0.003
8991	BH00753WCU2	0.003
9091	BH00727WCU2	0.007
9091	BH00729WCU2	0.002
9091	BH00732WCU2	0.002
9091	BH00735WCU2	0.002
9091	BH00737WCU2	0.002
9191	BH00962WCU2	0.053
9191	BH00965WCU2	0.005
9191	BH00969WCU2	0.002
9191	BH00973WCU2	0.002
9191	BH00975WCU2	0.004
9691	BH01207WCU2	0.003
9691	BH01211WCU2	0.003
9691	BH01214WCU2	0.006
9391	All	Rejected
9591	All	Rejected
9791	BH01218WCU2	0.003
9791	BH01221WCU2	0.004
9791	BH01223WCU2	0.003
12791	BH01239WCU2	0.003
12791	BH01240WCU2	0.003
13091	BH00347WCU2	0.002
13091	BH00348WCU2	0.002

Rejected Laboratory results validated as rejected.

TABLE 3-9

RANGE OF ORGANIC CONTAMINANTS IN 903 PAD AREA GROUNDWATER SAMPLES

Analyte	Carbon Tetrachloride				Chloroform				cis-1,2-Dichloroethene				1,1-Dichlororthene				Tetrachloroethene				Trichloroethene			
Tier I	500 ug/l				70,000 ug/l				7,000 ug/l				700 ug/l				500 ug/l				500 ug/l			
Well	Min	Q	Max	Q	Min	Q	Max	Q	Min	Q	Max	Q	Min	Q	Max	Q	Min	Q	Max	Q	Min	Q	Max	Q
6591	19		1,200	E	12		410		ND				ND		4.1		ND		2		ND		3.7	
6691	51	E	100,000.		92	E	64,000		ND		4		ND		36		9.4	E,B	4,600		ND		870	D,J
6791	3		10		0.3		0.8		.01		0.5		ND				ND		0.6		ND			
6891	ND		0.4		ND		ND		ND				ND				ND		2		ND		0.2	
6991	2.2		78		ND		2		7		65		ND		2		34	E	430	E	1.7		12	J
7191	ND		2.5	J	ND		2		ND		1		ND		71		51	E	1,100	D	2.6		140	E
7291	ND		0.4		ND		1		ND				ND				ND		58		ND		51	
8891	290	E	17,000		80	J	1,400	D	94	E	2,900		ND		83	E	470	E	20,000		210	E	4,600	E
9091	7		65		ND		11		ND		12		ND				0.3		7		2	J	15	
13091	ND		14		ND		4		ND		0.3		ND				ND		6		ND		1.1	
13191	122	E	4,800	E	60	E	1,000	E	ND		3		ND		780		23		130	E	ND		940	
13291	63		220		ND		44	E	ND		ND		ND		2.2		3.1	J	4.6		22		46	

ug/l micrograms/liter
Tier 1 RFCA Tier 1 ALP Action Level for Groundwater
Q Laboratory Qualifier
ND Not detected
D Compound ID using secondary dilution factor
E Concentration exceeds calibration range of instrument
J Estimated value, concentration greater than sample's detection limit

TABLE 3-10

RADIONUCLIDE CONTAMINANTS IN GROUNDWATER

WELLS ABOVE TIER II ACTION LEVELS

1991-1995

Analyte	Americium-241		Plutonium-239/240	
Tier I Action Level	14.5 pCi/L		15.1 pCi/L	
Well	Min (pCi/L)	Max (pCi/L)	Min (pCi/L)	Max (pCi/L)
06591	0.022	0.270	0.034	3.400
06691	0.160	0.580	0.778	2.900
06991	0.190	9.730	1.20	71.7
07191	0.030	2.270	0.832	3.361
08891	0.010	0.550	0.058	5.024
09091	1.400	46.540	12.0	354.6
13191	0.012	0.597	0.084	0.290

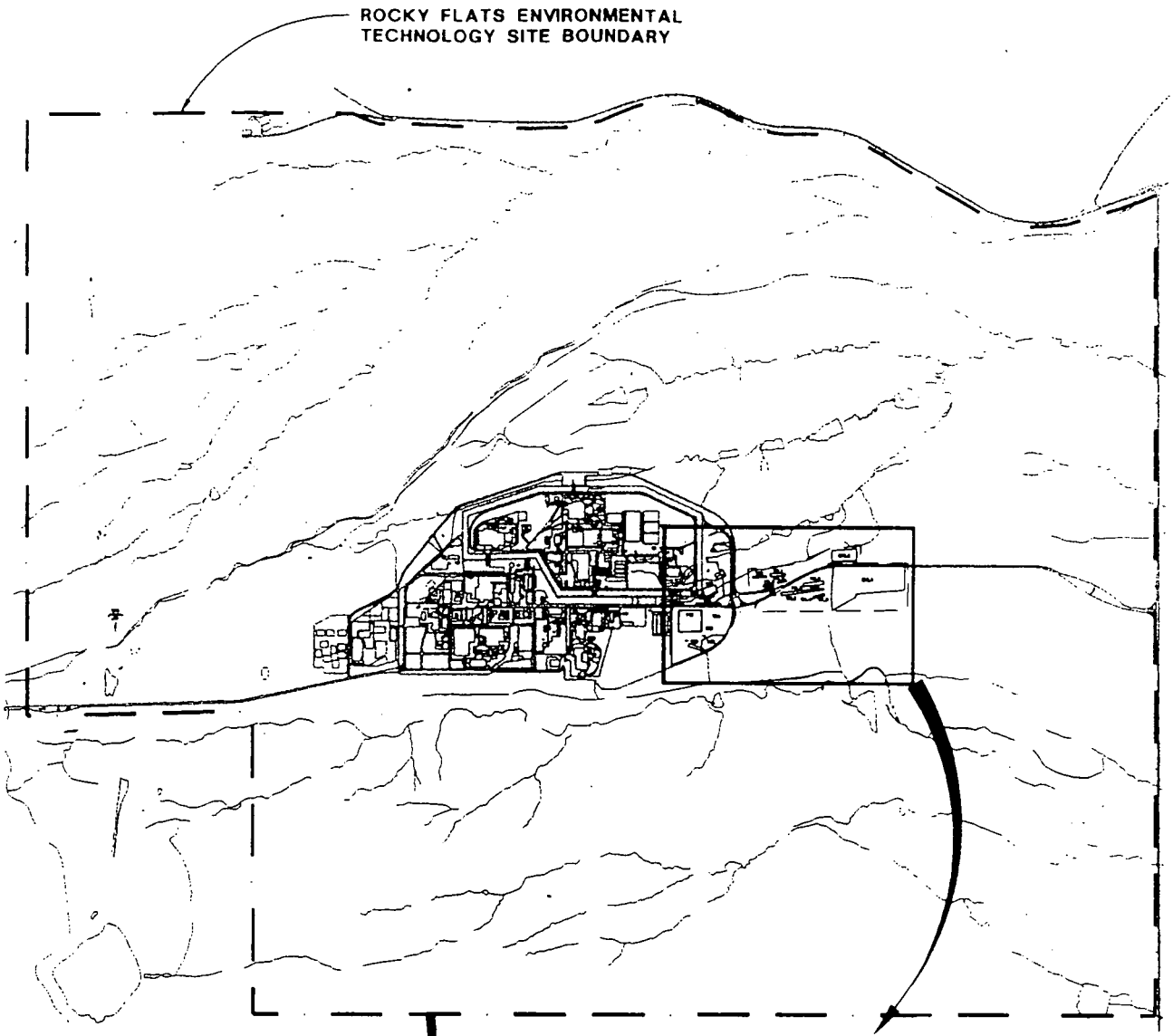
Note: Uranium-isotopic results were below background activities and are not provided.

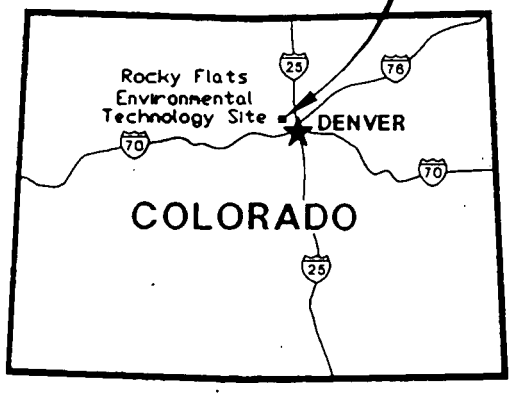
pCi/L micrograms/Liter.
Tier 1 RFCA Tier I ALF Groundwater Action Levels.

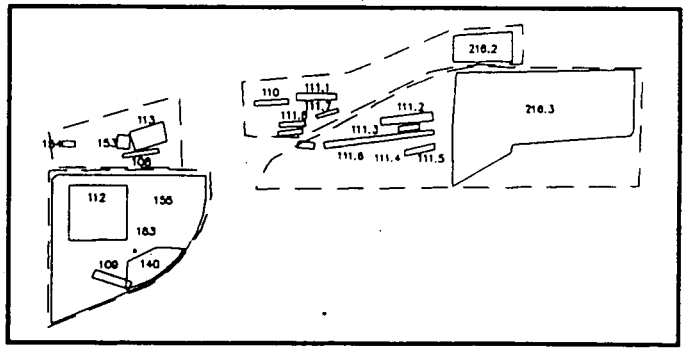
903 DRUM STORAGE SITE, 903 LIP AREA, AND NON-IHSS AREA DATA SUMMARY

FIGURES

(Figures *2-1 through 3-19)*







PREPARED FOR

U.S. DEPARTMENT OF ENERGY

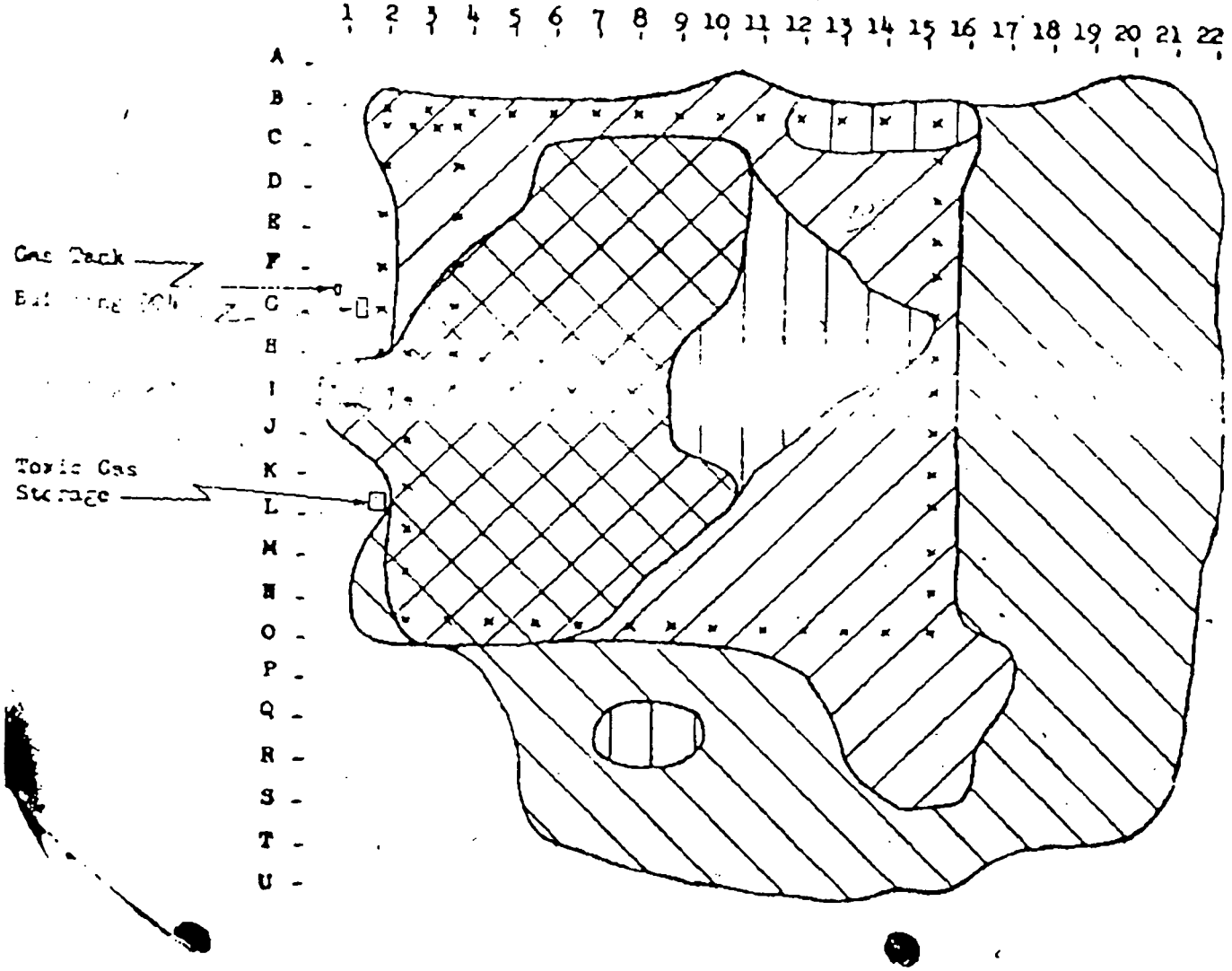
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Figure 2-1

903 Drum Storage Site Data Summary
Site Location Map

273015

PLUTONIUM SURFACE CONTAMINATION 903 AREA



N

KEY

- = Less than 6 ug/M²
- = 6 to 24 ug/M²
- = 25 to 100 ug/M²
- = 100 to 300 ug/M²
- = 300 to greater than 6,000 ug/M²

The above figures are relative rather than absolute. No correction has been made for penetration into the soil or the presence of vegetation.

Scale 1/4" = 25'

Figure 3-1

903 Drum Storage Site Data Summary
Plutonium Surface Contamination Map

Isopleth Level ($\mu g/m^2$)	Mean Level	(m^2) Area	Q g
——— 6	12.2	$9x10^3$	0.11
— - — 25	50	$5x10^3$	0.25
- - - - 100	173	$2x10^3$	0.35
——— 300	1340	$5x10^3$	6.7
			7.4

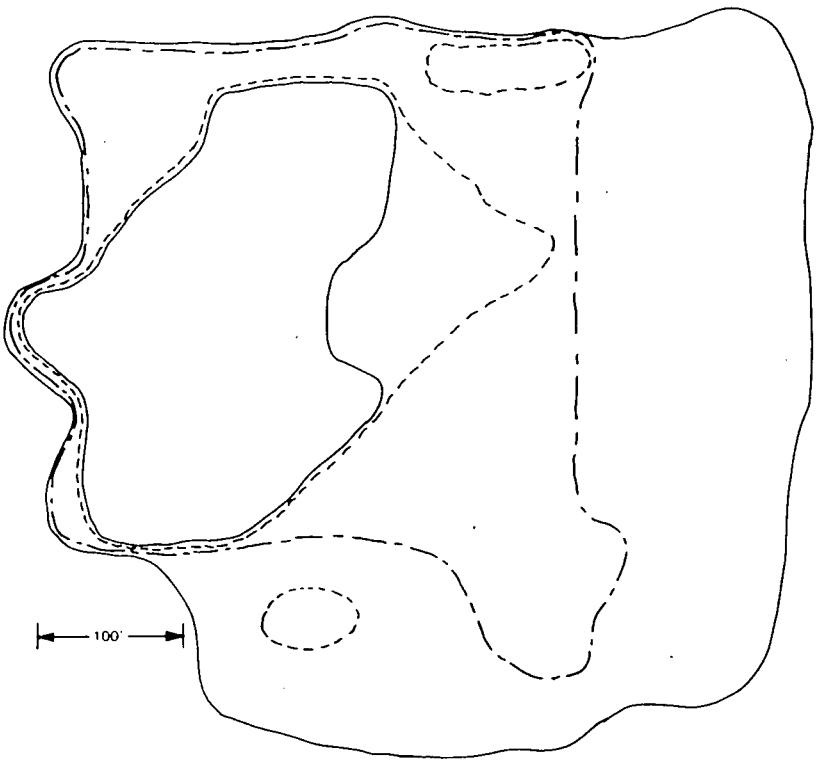
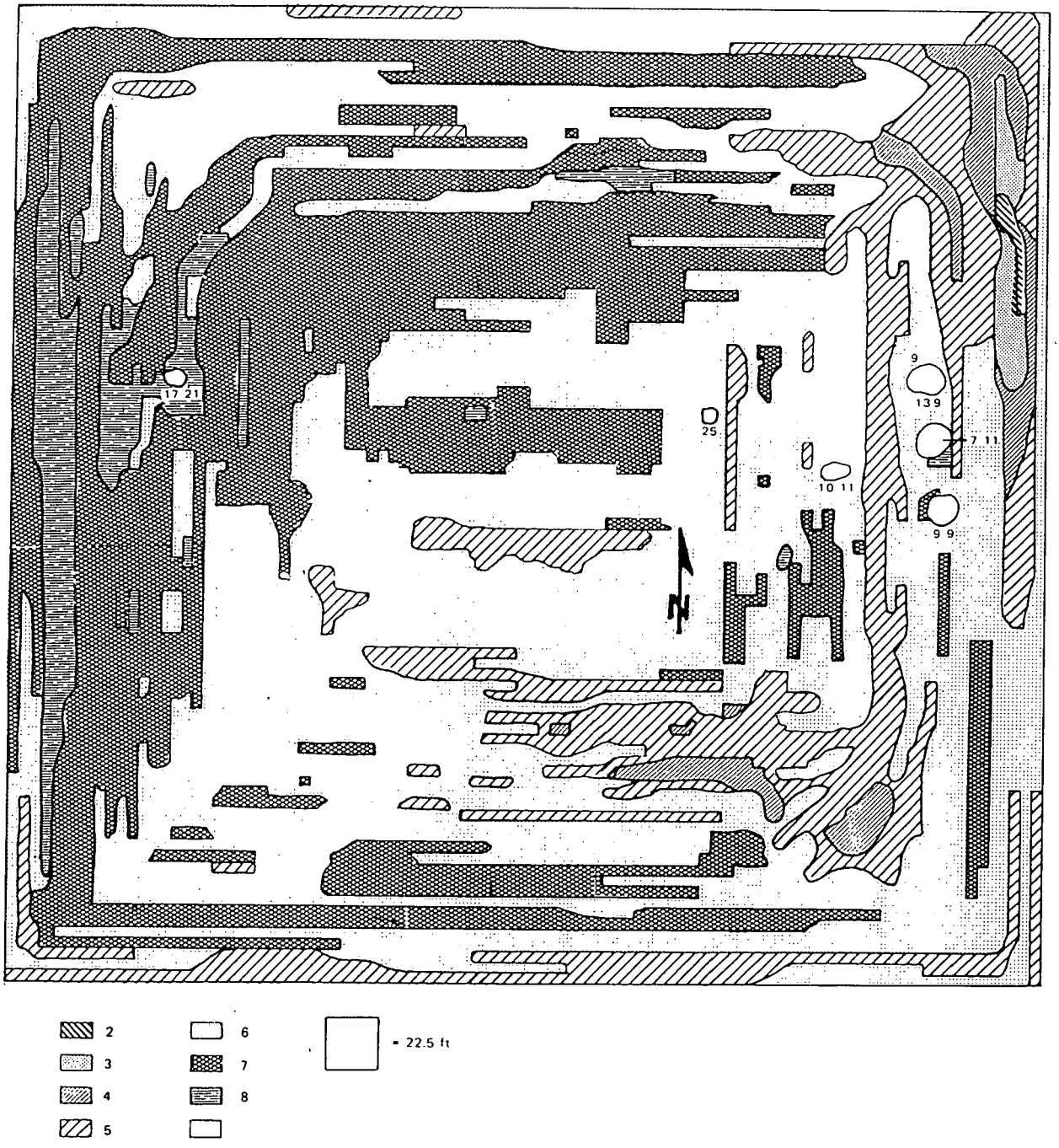


Figure 3-2

903 Drum Storage Site Data Summary
Plutonium Surface Contamination Map

FIGURE 3-3 Gamma-Ray Survey of Asphalt Surface of 903 Area Pad. The numbers represent only the relative gamma-ray readings at the pad surface. Each integer increment on the figure represents a change in counting rate of 1 to 2 percent.



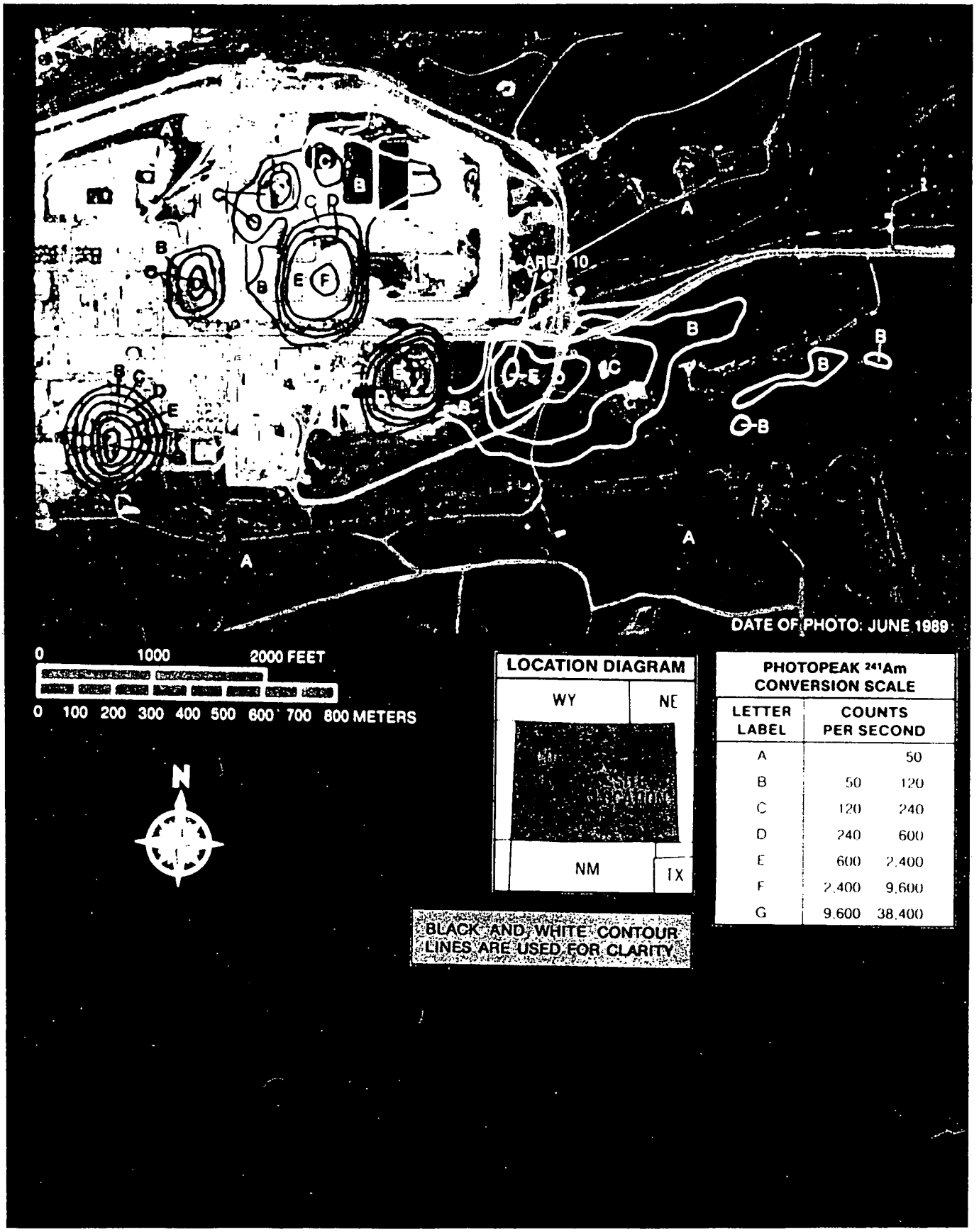
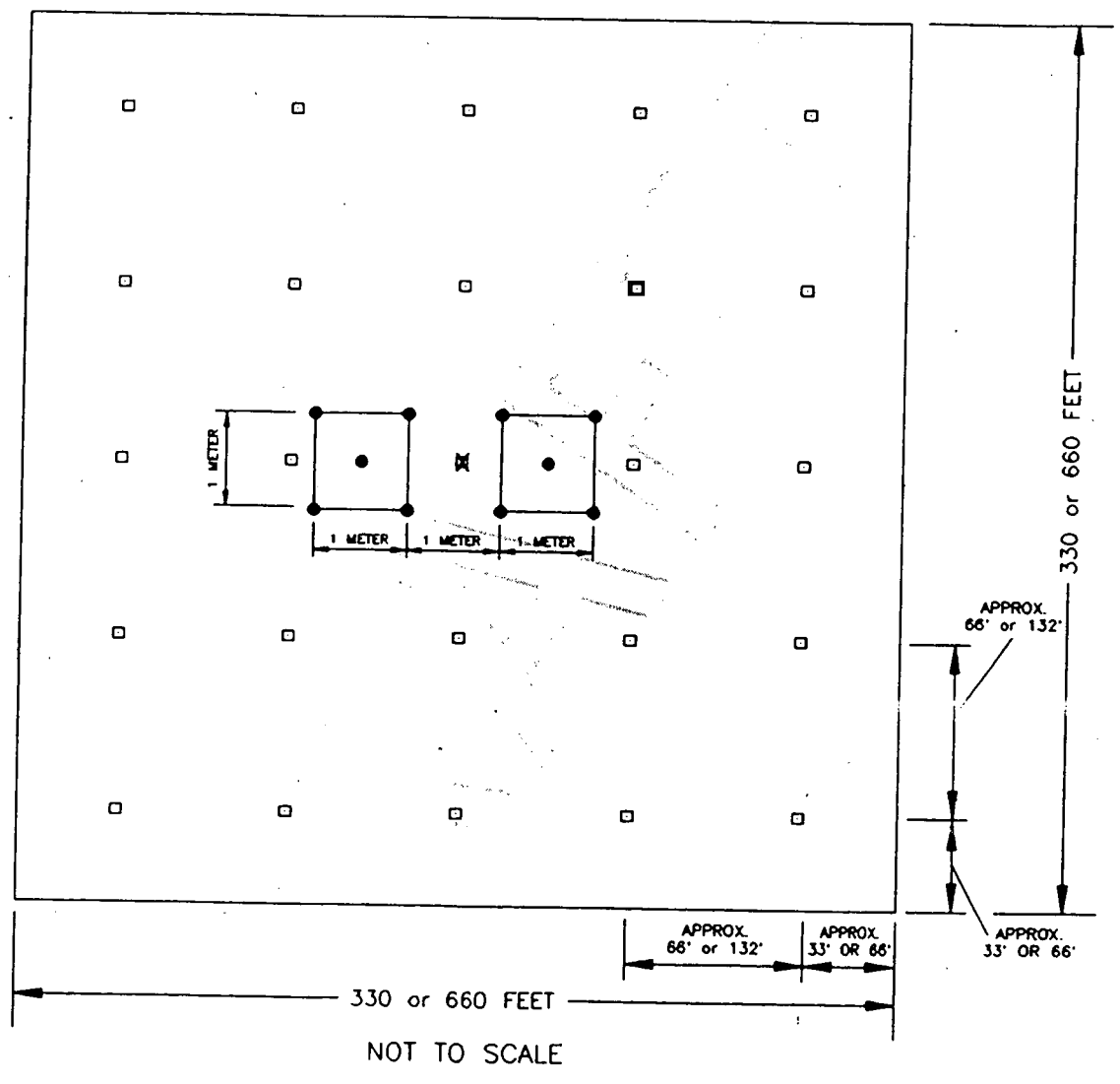


FIGURE 3-4 *AMERICIUM-241 PHOTOPEAK COUNT RATE ISOPLETH MAP*



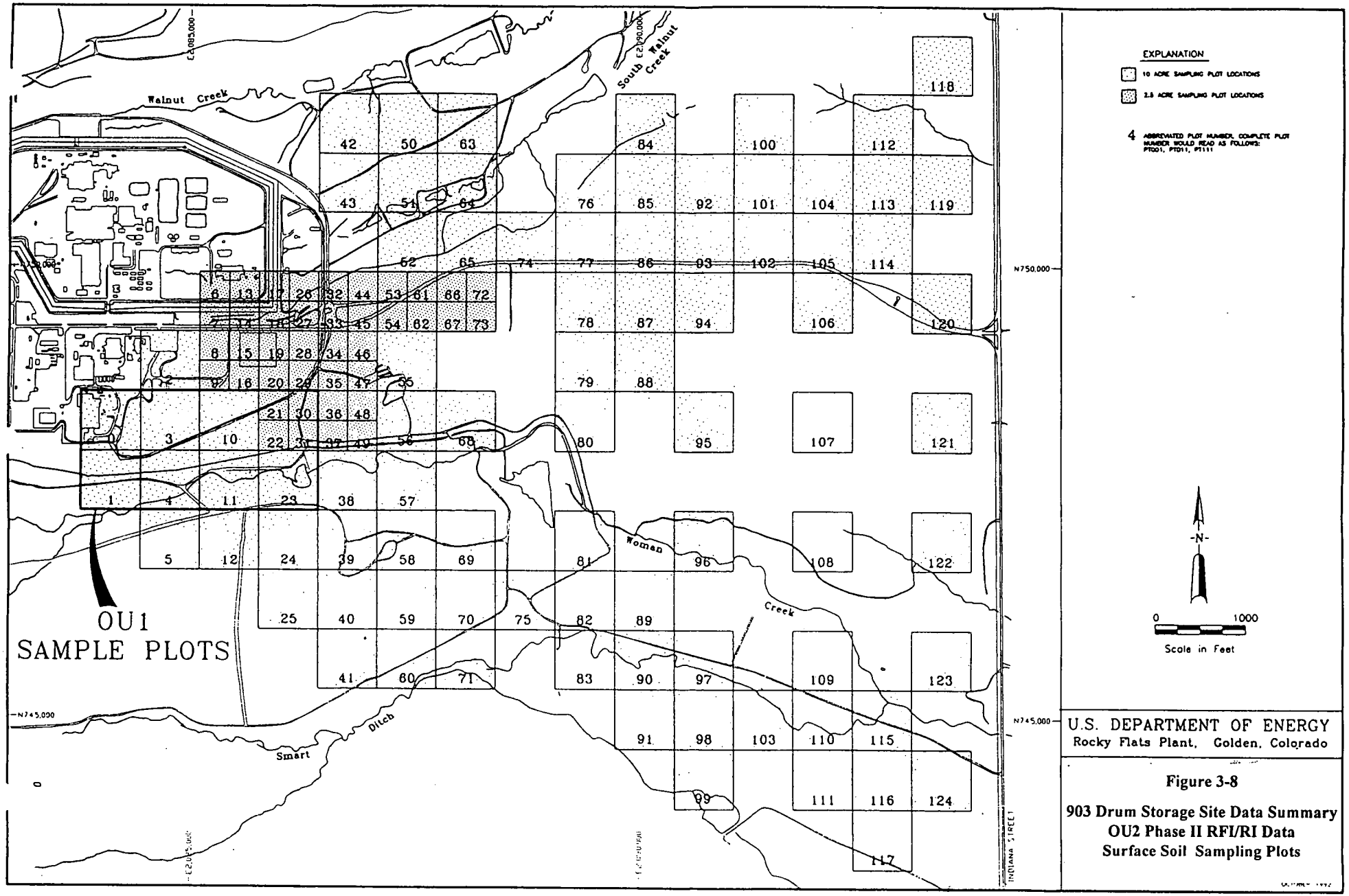
EXPLANATION

- X — CENTER OF PLOT
- ● — RFP METHOD SUBSAMPLE LOCATION (10 TOTAL)
- □ — CDH METHOD SUBSAMPLE LOCATION (25 TOTAL)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Environmental Technology Site
Golden, Colorado

Figure 3-7

903 Drum Storage Site Data Summary
OU2 Phase II RFI/RI Data
Typical CDH and RFP Sampling Schemes



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

Figure 3-8

903 Drum Storage Site Data Summary
OU2 Phase II RFI/RI Data
Surface Soil Sampling Plots

974259 MBWB020494/959

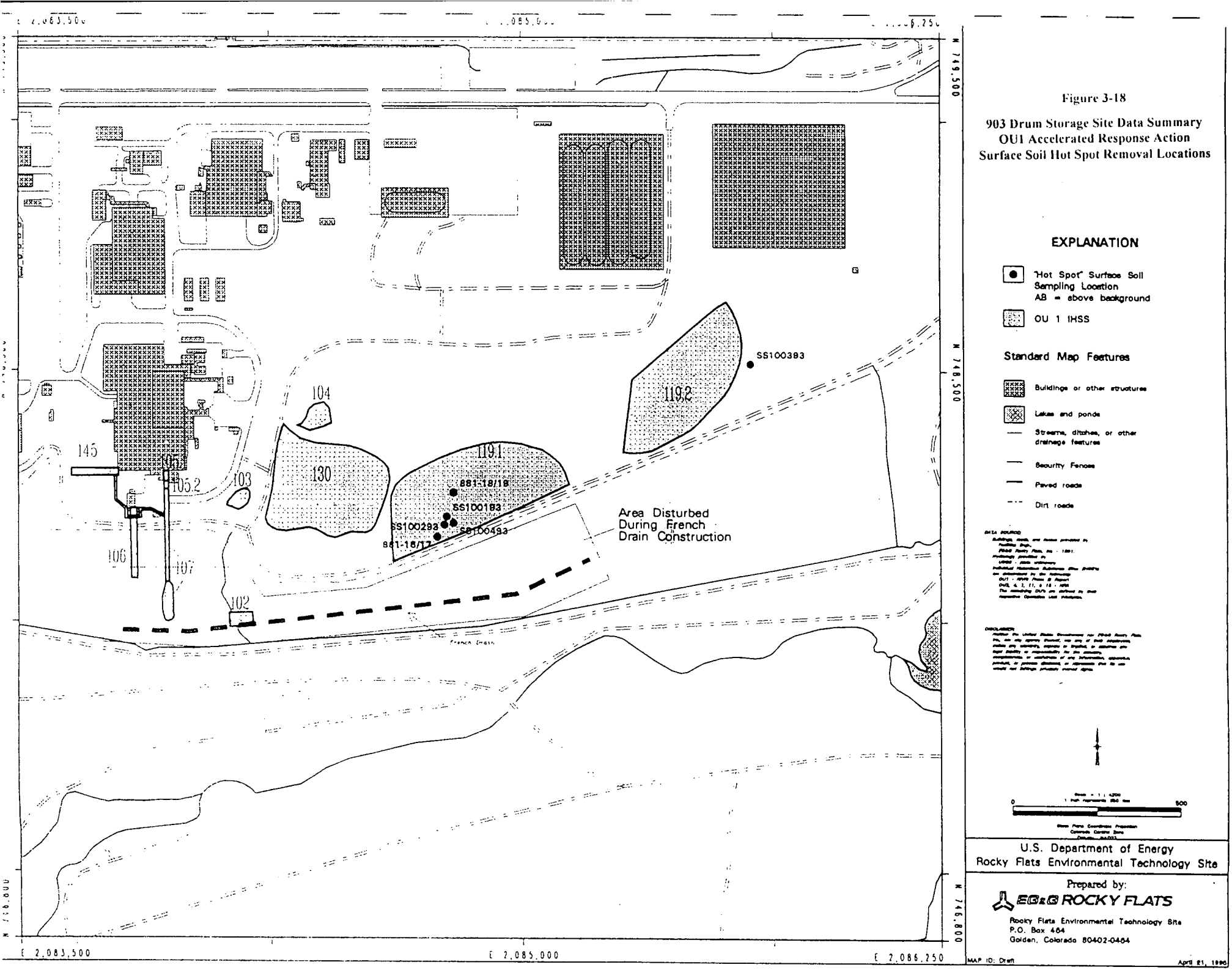


Figure 3-18

903 Drum Storage Site Data Summary
OU1 Accelerated Response Action
Surface Soil Hot Spot Removal Locations

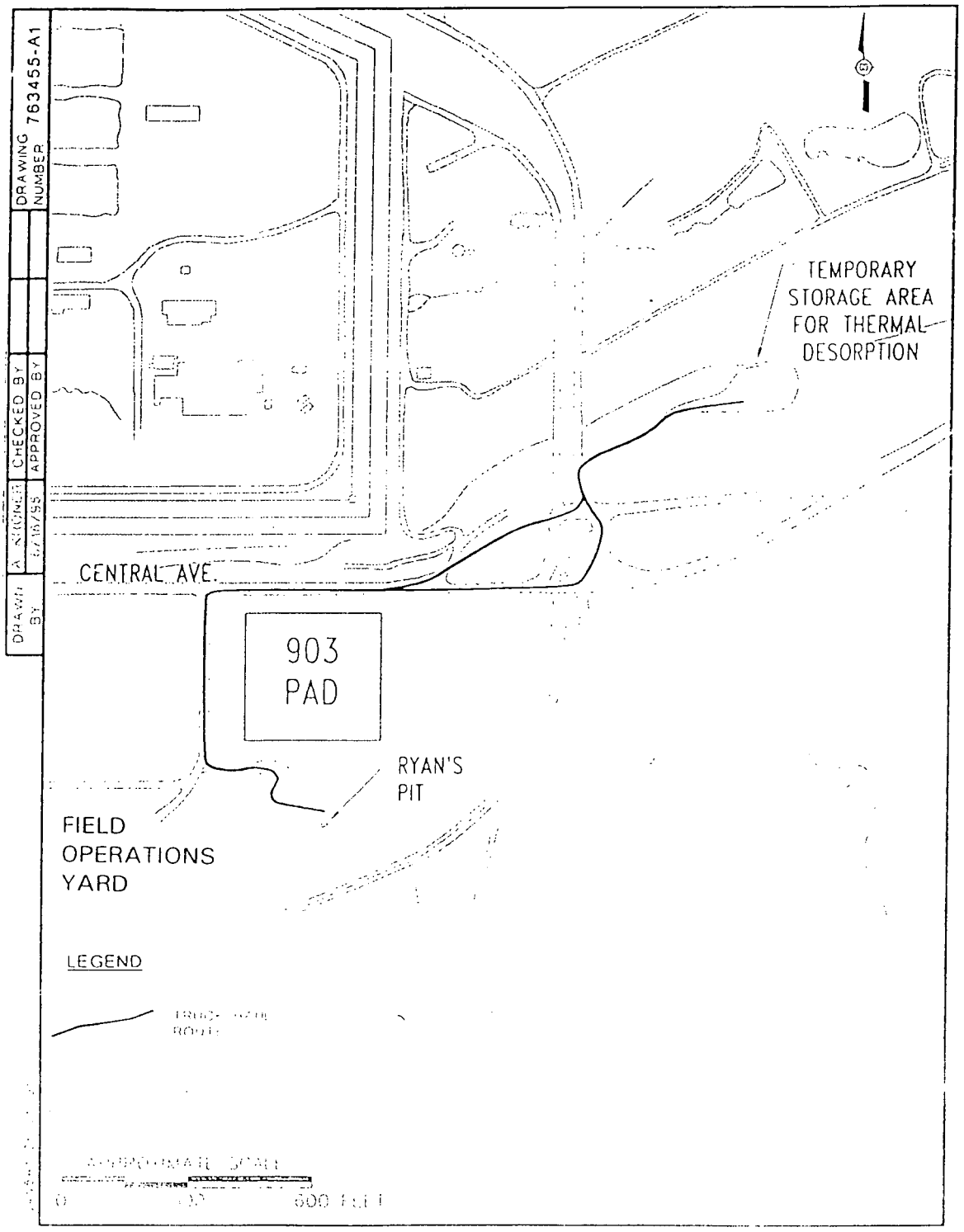


Figure 3-19

903 Drum Storage Site Data Summary
Ryan's Pit Site Map

903 DRUM STORAGE SITE,
903 LIP AREA, AND
NON-IHSS AREA
DATA SUMMARY

APPENDIX A

Data Source: EMF

Title: PLUTONIUM SURFACE CONTAMINATION 903 AREA

Keywords: KEYWORDS: ; WASTE STORAGE;WASTE OIL & SOLVENTS;CONTAMINATED SOIL;903/904 PAD CONTAMINATION/INCIDENTS; NAMES IN TEXT:

Comments:

Authors: OWEN JB; DOW CHEMICAL ROCKY FLATS

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00006451

THE DOW CHEMICAL COMPANY

ROCKY FLATS DIVISION
P. O. BOX 888
GOLDEN, COLORADO 80401

July 25, 1968

Copy to Lu Mathews 12/17/68
also to L. W. Meyers 1/20/69 (AEC-RF)

J. Seastone

PLUTONIUM SURFACE CONTAMINATION, 903 AREA

Health Physics has completed a survey of the plutonium contamination present on the surface of the 903 area. The following describes the techniques used, conditions in the area during the survey, survey results, and the Health Physics recommendation for corrective action.

A grid system was established which extended approximately 25 feet outside of the fenced area in all directions. Wooden stakes were placed at intervals of 25 feet along each grid line and the maximum level of contamination within 1 foot of each stake was determined. Significant levels of contamination were noted on the east and south boundaries of the grid system so the system was extended an additional 125 feet in these directions to more accurately determine the size and shape of the significantly contaminated area.

Vegetation is very sparse inside of the fenced area and the levels of contamination were determined for the most part on bare soil. Vegetation outside of the fenced area is relatively heavy and although attempts were made to reach the soil the levels of contamination are in many cases influenced downward due to a greater distance and vegetation between the probe and the soil. All of the surveys were taken during periods when the temperature ranged from 75 to 95 degrees Fahrenheit. There had been no significant rain fall during the previous week to ten days.

The results of the survey are displayed on the attached diagram. Information used in converting the survey results to micrograms per square meter was obtained from the "Emergency Radiation Monitoring Team Training Manual" prepared by Reynolds Electrical and Engineering Company, Incorporated (REECO), Mercury, Nevada, for use in Operation "Hot Spot". The conversion factors are for "fresh fallout".

The contamination in the 903 area is not "fresh fallout". Within the fenced area and 1 spot estimated at from 100 to 300 micrograms per square meter south of the fenced area, the contamination is due to leaking drums. The contamination was carried into the soil by a liquid. The soil conditions in this area do not permit accurate penetration determinations, but a spot survey in the southwest section indicated 60 micrograms per square meter at a depth of 8 inches with no indication of having reached the limit of penetration.

The effects of wind, rain, snow, and work in the fenced area, including purposely covering high level contamination with clean soil and gravel, have not been determined, but it is known that these factors result in the survey indicating less plutonium than the actual amount present. Inside of the fenced area the actual amount of plutonium present may be as much as 1,000 times more than is indicated by the survey results.

The contamination in the remaining area outside of the fence is due to wind and ground water runoff from the fenced area. No attempts have been made to determine the depth of penetration in this area, but it is reasonable to assume that the penetration is not more than 1 or 2 inches deep and that the actual amount of plutonium present is not more than 100 times greater than the amount indicated by the survey results.

The survey results must, therefore, be considered as relative rather than absolute numbers. To establish absolute values would require an extensive soil sampling program. This was considered too time consuming, too expensive and not necessary in order to consider the solutions to the problem.

In considering the solutions to the problem, one can refer to the REECO training manual and the "ALO Radiological Assistance Plan". To quote from the REECO training manual:

> "The most desirable objective for decontamination would be to remove all traces of contamination, at least to 1 or 2 micrograms per square meter. However, in many, perhaps most, cases this will not be possible. Therefore, suggested maximum levels for determining decontamination and relative hazards in Pu^{239} areas are as follows:

MEASUREMENT	HAZARD POTENTIAL
Greater than 3500 micrograms per square meter	Extremely hazardous
Greater than 1000 micrograms per square meter	Some hazard - decontaminate
Less than 1000 micrograms per square meter	Little hazard - decontaminate if in public interest."

To quote from the "ALO Radiological Assistance Plan":

> "If initial plutonium contamination is greater than 1000 micrograms per square meter decontamination should be

effected. (If initial contamination is less than 1000 micrograms per square meter, the area should be decontaminated only to a value consistent with reasonable effort and cost.)"

It is obvious that actions must be taken to correct the conditions in this area and that weather will continue to spread the contamination and distort the survey results. Health Physics recommends that the following actions be taken, in the order listed, as soon as possible. Respiratory protection, plant clothing, and monitoring will be provided as required.

1. There are two forklift trucks in the fenced area. Crate and dispose of these forklifts as contaminated waste.

2. Move the toxic gas storage building to a new location.

3. Remove the fence from the south and east sides of the area. Dispose of the fence as contaminated waste.

4. Remove the soil and rock from the spot of from 100 to 300 micrograms per square meter south of the fenced area by hand. Place the soil and rock inside of the fenced area. Dampen or oil the area to avoid creating dust during the removal.

5. Bulldoze the soil and rock to a depth of from 4 to 6 inches from the contaminated areas outside of the fence to the east and south into the fenced area. Dampen or oil the area to avoid creating dust during the operation.

   This soil and rock is to be used to start to bring the level of the fenced area up to the highest point in the fenced area. The area within the fence is not to be bulldozed.

   This should be done with the bulldozer which Plant Services (Jack Seastone) has obtained from surplus. It may become necessary to dispose of this bulldozer as contaminated waste.

6. Remove the tanks west of Building 903. Dispose of the tanks as contaminated waste.

7. Remove the fence in the northwest section and from the north and west sides of the area. Dispose of the fences as contaminated waste.

8. Remove the gas tank west of Building 904 and return it to the vendor.

9. Move Buildings 903 and 904 to their new locations.

10. Bring in additional soil and gravel to cover and complete the raising of the fenced area up to and cover the highest point in the fenced area. This cover is to extend 25 feet beyond the fenced area in all directions and is to be of a thickness and texture to serve as a base for a concrete pad.

    This cover can be applied by a contractor starting along the north side and grading to the south with the grader remaining on the new cover.

11. The contractor is to pour a concrete pad over the area. The pad is to be poured in a manner which will assure that ground water will not run under it and that water from rain or snow will not penetrate it.

This will insure containment of the contamination and prevent the contamination from possibly reaching the underground water.

It is further recommended that this area be used for the storage and loading of contaminated waste. It should be fairly simple to move Building 663 to the pad, install a platform scale, and provide truck docks along the south side of the pad so that the drums and most of the crates can be loaded with a forklift. This will significantly reduce the use of the crane for loading crates and free the 600 area of the plant for other uses.

Health Physics is available for further discussion of this problem as required.

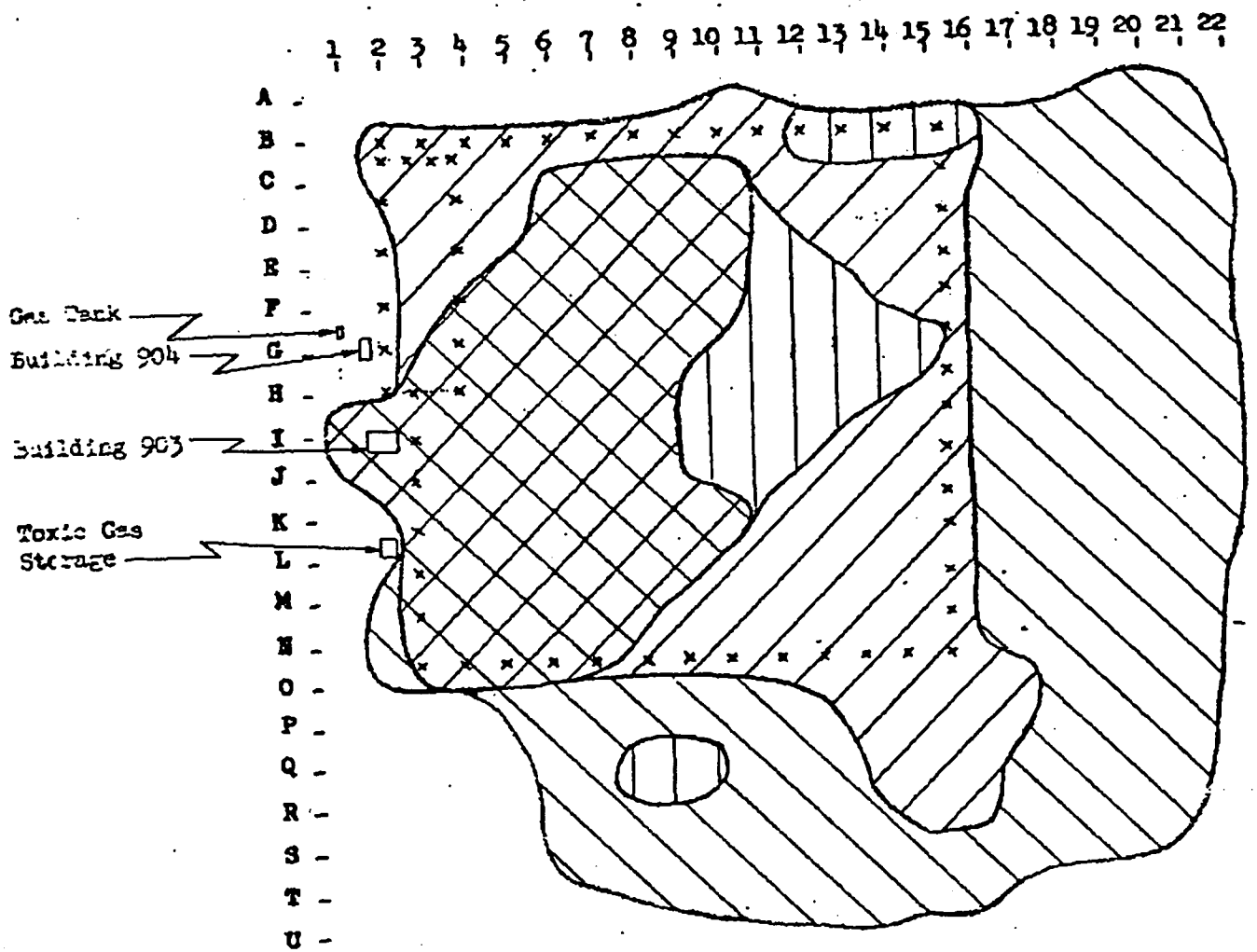
J. B. Owen

J. B. Owen
Health Physics

JBO:slg
Enc.

cc:
D. M. Bassler
J. G. Epp
C. M. Love
C. W. Piltingsrud
E. A. Putzier
E. J. Walko

PLUTONIUM SURFACE CONTAMINATION 903 AREA



N

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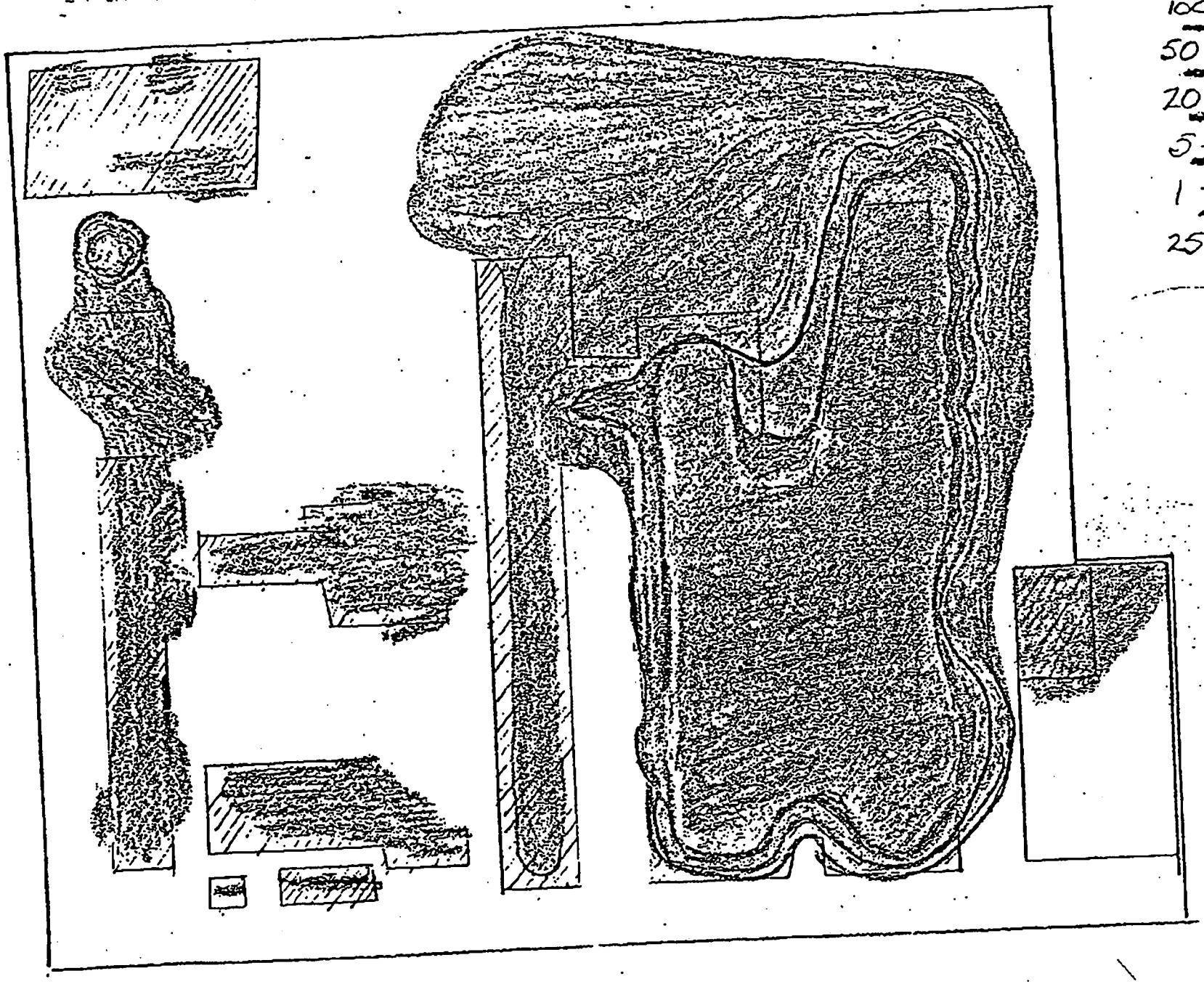
Scale 1/4" = 25'



11-19-65
SURVEY BY
KYDEN & JOHNSON

903 DRUM STORAGE SITE,
903 LIP AREA, AND
NON-IHSS AREA
DATA SUMMARY

APPENDIX B

DRAFT
DATA USABILITY EVALUATION
of
RADIOANALYICAL RESULTS
for
SURFACE SOIL REMEDIATION STRATEGIES
in the
903 PAD AREA.

Rock Mountain Remediation Services

April, 1997

Revision No.____

Document Control No: RF/RMRS-07-_____

TABLE OF CONTENTS

EXECUTIVE SUMMARY

A comprehensive evaluation of radiochemistry data acquired within the ER program over the past several years has been completed for the purpose of evaluating the data's usability relative to potential remediation of radionuclides within the soils at and near the 903 Pad area. The data sets reviewed include OU-1 Phase III RFI/RI surficial soils, OU-2 Phase II RFI/RI surficial soils, and trenches throughout several operable units as well as the buffer zone. Evaluation of the data for usability relative to environmental decision-making satisfies a major quality requirement of the ER program.
The data sets were chosen based on their areal extent with respect to the 903 Pad and the time frame in which the data were acquired. The success of any remediation effort hinges on the confidence of "knowing" the areal and vertical extent of contaminant concentrations relative to action levels (i.e. cleanup levels). The time frame of the data sets evaluated was significant because the data were acquired within an established environmental Quality Assurance program, consistent with the goal of producing defensible data and consequent environmental decisions.

In general, and from a radiochemistry perspective, all data qualified as valid (flagged as "V"), acceptable with qualification (flagged as "A"), or unflagged, is usable, based on the well-established, formal data validation process. Rejected data (flagged as "R") is not usable for the same reason. Because such a vast majority of the radionuclide dataset underwent the formal validation process with high percentages of valid and acceptable data (Luker et al., 1994), inferences about (analytical/radiochemistry) data usability have a high confidence throughout the ER program as a whole. Generally, all data not rejected by the validation process are usable. Validation qualifiers directly and adequately address such usability criteria as "precision" and "accuracy"; however, data usability based on "representativeness", "completeness", and "comparability" relies less on data validation criteria and more on the data as compared with project objectives. Such comparisons given in this report do not disqualify any data beyond those rejected data from the validation process. However, it must be emphasized that details of this usability analysis are with respect to a procedure designed to measure compliance to work plans already implemented (e.g., OU-2 Phase II RFI/RI Work Plan), and not with current remedial action plans. Inputting selected, usable data into impending remediation strategies (work plans) is the next step.

The foremost precaution warranted for use of previously collected RFI/RI data is that of representativeness: this is the weakest aspect of the usability argument, as compliance with the RFI/RI work plan(s) is the primary basis for establishing representativeness. It must be ensured that the samples used to estimate radionuclide activity levels directly support the latest remediation goals (especially with respect to 3-D locations), and not simply compliance with previous RFI/RI (characterization) work plans. For example, one analytical result may represent up to 10 acres of areal extent (Colorado Department of Health {CDH} method) while another may represent point-locations (trench/pit samples). If the desired areal control of remediation is to be "tighter" than the areal control provided by composite sampling, further sampling control will be necessary. Conversely, if such gross areas are not within a remediation area of interest (e.g., on the outer periphery of the buffer zone), previous composite sampling over the area is probably adequate as a gross characterization of large, peripheral areal plots.

1.0 PURPOSE

The purpose of this report is to provide the results of Environmental Restoration Management's Procedure 2-G32-ER-ADM-08.02, *Evaluation of ERM Data for Usability in Final Reports*, to indicate surficial soil data usability for OU-2 remediation strategies. The data evaluated by this procedure include surface soil samples analyzed for radionuclides that span several projects; over 118 plots utilizing CDH and RFP sampling methods, over 28 plots utilizing RFP sampling methods for the OU1 Phase III RFI/RI, and 26 trenches based on the OU-2 Phase II RFI/RI work plan.

2.0 BACKGROUND

Regarding the Phase II RFI/RI Report 903 Pad, Mound, and East Trenches Area, Operable Unit No.2 dated October 1995, numerous surface soil sampling programs were implemented in support of the OU2 RFI/RI including:

- The sampling of 118 plots using the CDH sampling method to determine spatial extent of radiological contamination including plutonium-239/240, americium-241, and uranium isotopes;
- The sampling of 118 plots using the RFP sampling method for americium-241 and plutonium-239/240 comparison with the CDH sampling method;
- The sampling of 26 pits using trenching methods to determine the vertical extent of radiological contamination; and
- The sampling of 40 locations to generate data for use in the risk assessment.

Two separate evaluations were performed specific to the OU-2 surficial soils data: the CDH sampling program and the RFP sampling program.

Other surface soil sampling programs were implemented during the OU2 RFI/RI, which were intended to support the OU1 RFI/RI including:

- The sampling of 118 plots using the CDH sampling method to determine spatial extent of radiological contamination including plutonium-239/240, americium-241, and uranium isotopes. Seven of the 10-acre plots and four of the 2.5-acre plots fall partially or entirely in OU1;
- The sampling of 118 plots using the RFP sampling method for americium-241 and plutonium-239/240 to compare with the CDH sampling method;
- The sampling of 26 pits using trenching methods to determine the vertical extent of radiological contamination. Three of these pits are located within OU1.

A surface soil sampling program was implemented in support of the OU1 Phase III RFI/RI baseline risk assessment. The OU1 area was divided into four-hundred-fifty 50- by 100-foot contiguous rectangle plots, which were sequentially number. Twenty-four of the plots were selected for sampling by matching the plots with numbers generated from a random number generating process. Four biased sampling locations were selected to include IHSSs 106, 130, 119.1 and 119.2 because they were most likely to have surface soil contamination based on site histories -- contaminated liquid discharges, stored, drummed wastes, or wastes were buried at shallow depths. Data associated with the 4 discrete sampling locations identified in Technical Memorandum 5 is not being evaluated in this effort. These data were previously addressed under the OU1 Hot Spot Removal Action.

The final subset of data was collected from Trenches 1-26 in support of the OU2 Phase II RFI/RI. These samples were collected at the surface (0-3 cm. and 3-6cm.) and to approximately one meter in depth.

3.0 WORK PLAN REQUIREMENTS

3.1 OU-1 PHASE III RFI/RI SURFICIAL SOIL DATA

Draft Final Technical Memorandum 5, Addendum to the Final Phase III RFI/RI Work Plan, Surface Soil Sampling and Analysis Plan, Rocky Flats Plant, 881 Hillside Area (Operable Unit No.1) provides the scope of the surface soil sampling program.

The program included collecting samples over a grid covering approximately 52 acres. The OU1 area was divided into four-hundred-fifty 50- by 100-foot contiguous rectangle plots, which were sequentially number. Twenty-four of the plots were selected for sampling by matching the plots with numbers generated from a random number generating process. Four biased sampling locations were selected for sampling in IHSSs 106, 130, 119.1 and 119.2. The samples were planned with the RFP sampling method – a mixture of 10 grab subsamples from which one composite sample was generated for analysis. Random subsamples from the composite were withdrawn and measured for numerous analytical measurements. With through mixing, a physical averaging took place, so that the final sample analyzed represented an average concentration of the original grab subsamples and their respective locations.

The Work Plan proposed 24 plots and four discrete locations for a total of 28 surface soil samples using the RFP method.

The Draft Final Technical Memorandum 5, Addendum to the Final Phase III RFI/RI Work Plan, Surface Soil Sampling and Analysis Plan, Rocky Flats Plant, 881 Hillside Area (Operable Unit No.1) provides the surface soil sampling programs QA/QC requirements. The analysis program include gross alpha, gross beta, plutonium-239/240, americium-241, uranium-233/234, uranium-235, uranium-238, radium-226, and Radium 228. However, only results of radionuclides identified in the RFCA (Pu, Am, U-233/234, U-235, and U-238) warrant evaluation.

The OU1 Technical Memorandum No.5 QAA did not state rationale for the evaluation of equipment rinsate blank results. Risk Assessment Guidance for Superfund (RAGS, 1989) rationale was better suited for this evaluation . RAGS states that if the contaminant is not a common laboratory contaminant then "*consider site sample results as positive only if the concentration of the chemical in the site sample exceeds five times the maximum amount detected in any blank*". Rinsate samples were evaluated relative to the RAGS guidance, as well as using RFCA action levels to qualitatively compare to field blank values.

The OU1 TM5 did not specify rationale for the evaluation of duplicate sample results. Therefore, consistent with other Environmental Restoration projects at RFETS, the DQO for field duplicate samples was 40 percent relative percent difference for homogenous, non-aqueous samples.

3.2 OU-2 PHASE II RFI/RI SURFICIAL SOIL DATA

Technical Memorandum 1 to the Final Phase II RFI/RI Work Plan (Alluvial) provided the scope of the surface soil sampling program. The program planned samples over a grid covering approximately 800 acres. The State of Colorado requires special techniques for construction on lands with plutonium-239/240 concentrations greater than 0.9 pCi/g of dry soil. To evaluate the soil-plutonium-239/240 values relative to this guideline, the CDH sampling method was employed. However, CDPHE (formerly CDH) has subsequently stated that the standard does not apply to the Rocky Flats site. The CDH sampling protocol required 25 samples to be composited within a 10-acre area for analysis. Because of the large

concentrations in soil-plutonium-239/240 near the source, a 2.5-acre grid was sampled immediately east of the 903 Pad and around the East Trenches area.

The Work Plan proposed 124 plots for sampling using the CDH method. Eighty-four 4.05-ha plots and thirty-four 1.01-ha plots were sampled for a total of 118 plots. Plots 2, 8, and 9 were not sampled because they were covered with structures and/or pavement. Plots 7, 14, 17, and 18 were not sampled because the plots were inside the Protected Area, where the surface is highly disturbed. Plot 0 was added during the field implementation stage.

The Quality Assurance Addendum, QAA 2., to the Rocky Flats Plant Site-Wide QA Project Plan for CERCLA RI/RS and RCRA RFI/RI/CMS Activities for Operable Unit No.2 (Alluvial), 903 Pad, Mound, and East Trenches Area Phase II RFI/RI, August 1991 provided the data quality objects and sampling program for the surficial soils sampling program. The analysis program include Plutonium-239/240, Americium-241, and Uranium-233/234, Uranium-235, and Uranium-238.

The OU2 Work Plan did not propose the RFP sampling method. It appears that the sampling program was added later to determine if sampling methods impacted RFI/RI conclusions on radionuclide (activity) areal distributions.

Litaor (unpublished) states: "During the initial phase of the field work for OU 2, it became evident that using the CDPHE sampler for the stated objective may be difficult to implement. The CDPHE sampler collects only the top 0.64 cm of the soil. This minimal sampling depth exhibited two serious problems; (1) it was difficult to assess the exact boundary between the impacted soil surface and the litter layer accumulated above, and (2) the soils within the RFETS have been undisturbed for the last 30 years, which facilitated eolian accumulation and soil development with little or no surface erosion. This phenomenon may comprise the main objective of the study to provide a reliable spatial distribution of PU-239+240 in the soil environment around RFETS. Hence, a comparative study was conducted to assess actinide activity using the CDPHE and the Rocky Flats (RF) sampling techniques."

Litaor applied the Wilcoxon Signed Rank test to compare the two sampling techniques and states:

"The WSR is a non-parametric test because it uses the ranks of the data as opposed to data themselves. Two statistical tests were conducted . In the first test the PU-239+240 activities in the entire data set of 167 RF samples were compared against the 167 CDPHE samples collected from the same plots. There was no significant differences at the 95-percent confidence level between the two sampling procedures. Because Pu-239+240 activity in soil changed significantly with distance and direction from the former storage site, a distance-dependent data design was developed. There were no significant differences between the two sampling procedures in most distance classes. The findings of this comparative study suggest that for the purpose of ecological risk assessment, the soil sampling technique has little effect on the outcome of the analysis."

The RFP method was used to sample the 118 locations where CDH samples were collected. However, only data for only 106 locations were downloaded from RFEDS. Plutonium-239/240 and americium were analyzed. The OU2 QAA states that uranium isotopes would be performed on surface soil samples Eight duplicate samples and six rinsate samples were collected. No results for samples collected using the RFP method are presented in OU2 Phase II report.

The OU2 QAA provided the data quality objects and sampling program for the surficial soils sampling program. These samples were collected in support of the OU2 Phase II RFI/RI, with required conformance to the QAA requirements set forth in the OU2 QAA. The QAA requirements have been previously provided in the CDH method section.

3.3 SOIL PROFILE DATA

The OU2 Work Plan proposed the excavation of 26 pits, 1.5 meter long, 1.9 meter wide and 1.0 meter deep, in order to access the vertical migration of plutonium-239/240 and americium-241 in soils east and south of the RFETS. Surface soil samples from the 26 soil profiles were planned using a modified trench method (Harley, 1972). Ten samples were collected over 3 centimeter intervals, beginning at the deepest block in the excavation. The samples were collected using a stainless steel scoop and template (3 centimeters x 20 centimeters) which were pressed into the wall of the excavation. Three samples from each depth were consolidated to provide a better representation of the site.

The Work Plan described studies of physicochemical association of plutonium and americium in soils east of the 903 Pad using a sequential extraction methodology. The soils were to be extracted into four major physicochemical fractions; carbonates, organics, sequioxides, and residuals. However, the Work Plan also stated that spikes of plutonium-237 were added to soil samples before each extraction step to evaluate possible readsorption. If serious postextraction readsorption (15%) took place, the sequential extraction process would not be performed and samples collected from Trenches 1 to 5 would be analyzed for total plutonium-239/240 and americium. The Phase II RFI/RI Report did not provide results of the plutonium-237 spikes. In addition, the report stated that digestion of samples was completed by microwave, therefore RFEDS results downloaded represent total radionuclide activity. Sequential extractions were not performed.

The OU2 QAA 2 provided the data quality objectives and sampling program for surficial soils sampling. These samples were collected in support of the OU2 Phase II RFI/RI and were required to conform to the QAA requirements set forth in the OU2 QAA.

4.0 RESULTS

The data sets from which this report were drawn consist of the following individual files, evaluated on Excel spreadsheets downloaded from the RFEDS, and queried based on project identifiers and three-dimensional locations of samples.

4.1 PRECISION

Use of field duplicates is the primary method of evaluation for overall precision of the radiochemistry process. One field duplicate collected for 20 real samples, or one per sampling event, whichever was more frequent, was the DQO of interest for evaluation of precision. Although several of the overall precision compliance numbers were below the typical data quality objectives of 40% (relative percent difference), all but one of the noncompliant values resulted exclusively from samples with very low absolute differences between QC and real samples radioactive levels (<7 pCi/g difference). Such discrepancies in reproducibility (^{239,240}Pu for the example cited) are two orders of magnitude less than the respective Tier 1 action levels. Therefore, overall radiochemistry values for precision, or reproducibility -- which encompass both laboratory and field variability -- are satisfactory for the data sets reviewed. Recall that "overall" precision includes variability within the lab's radiochemistry measurement process as well as that inherent within the field sampling's standard operating procedures and decontamination protocols. The one exception to this general conclusion is considered, qualitatively, as an outlier, where the delta value was ~10.6 nCi/g.

It should be noted for future radionuclide sampling/analysis that a DQO of 40% RPD for overall project precision is ambitious (i.e., unrealistic for 100% compliance), due to the typically low levels of radionuclides found in environmental samples. Further, the DQO was based on standard analytical chemistry methods -- organics and inorganics -- at the outsets of the cited projects, and was simply

adapted to radiochemistry out of convenience and a conservative approach to QC of the sampling/analysis process. Two values that exceeded a 7 pCi/g delta (discussed above) were from samples with significant "hits", but as such, were within the DQO of <40%RPD.

Observations on precision are discussed below , by project.

4.1.1 OU-1 PHASE III RFI/RI SURFICIAL SOIL DATA

The data quality objective for field duplicate samples was ≤40% RPD for homogenous, non-aqueous samples. Summary results are provided below, while absolute and delta value are shown in Table 4-1, where values are sorted by the absolute difference ("DELTA") in results and in descending order.

OU1 Phase III RFI/RI - Modified RFP Sampling Method
Duplicate Sample Results

Analyte	Medium	Required RPD Value	Total Real Samples Collected	Total Duplicates Collected	Number of Duplicates within RPD	Overall Precision Compliance
Pu-239/240	Soil	≤ 40%	34	4	4	100%
Am-241	Soil	≤ 40%	34	4	1	25%
U-234/235	Soil	≤ 40%	34	4	3	75%
U-235	Soil	≤ 40%	34	4	3	75%
U-238	Soil	≤ 40%	34	4	3	75%

Overall, the RPD of less than or equal to 40% for duplicate samples was met for 70% of the duplicates collected. Sample results validated as rejected were not included in the evaluation. Based on the work plan, over 85% of the duplicates should have met the established DQO for precision.

4.1.2 OU-2 PHASE II RFI/RI SURFICIAL SOIL DATA

The data quality objective for field duplicate samples was ≤40% RPD for homogenous, non-aqueous samples (OU-2 QAA). Summary results are provided below, while absolute and delta value are shown in Table 4-2 (CDH-method) and Table 4-3 (RFP-method), where values are sorted by the absolute difference ("DELTA") and in descending order.

OU2 Phase II RFI/RI - CDH Sampling Method
Duplicate Results

Analyte	Medium	Required RPD Value	Total Real Samples Collected	Total Duplicates Collected	Number of Duplicates within RPD	Overall Precision Compliance
Pu-239/240	Soil	≤ 40%	118	7	6	86%
Am-241	Soil	≤ 40%	118	7	7	100%
U-234/235	Soil	≤ 40%	118	4	3	75%
U-235	Soil	≤ 40%	118	4	2	50%
U-238	Soil	≤ 40%	118	4	4	100%

Table 4-1.
OU-1 PHASE III RFI/RI
SURFICIAL SOILS
PRECISION RESULTS

Plot	QC Sample ID	Media	Detected Analyte	QC Sample Type	Associated Real Sample	QC Sample Result	Real Sample Result	DELTA (pCi/g)	RPD Value (%)
RA031	SS03051WS	SS	PU-239/40	DUP	SS03050WS	2.4110	3.0440	0.6330	23
RA031	SS03051WS	SS	U-238	DUP	SS03050WS	1.0790	1.5800	0.5010	38
RA011	SS03022WS	SS	U-238DA	DUP	SS03021WS	1.0940	0.7136	0.3804	42
RA031	SS03051WS	SS	URANIUM-233,-234	DUP	SS03050WS	0.8430	1.2150	0.3720	36
RA011	SS03025WS	SS	PU239/40	DUP	SS03024WS	1.5410	1.1750	0.3660	27
RA011	SS03022WS	SS	U-238DA	DUP	SS03021WS	0.9443	0.7136	0.2307	28
RA011	SS03022WS	SS	URANIUM-233,-234	DUP	SS03021WS	1.0260	0.8350	0.1910	21
RA015	SS03031WS	SS	URANIUM-233,-234	DUP	SS03030WS	1.3860	1.5300	0.1440	10
RA015	SS03031WS	SS	U-235	DUP	SS03030WS	0.1008	0.0406	0.0602	85
RA011	SS03025WS	SS	URANIUM-233,-234	DUP	SS03024WS	0.8337	0.7814	0.0523	6
RA015	SS03031WS	SS	U-238DA	DUP	SS03030WS	1.6140	1.5680	0.0460	3
RA011	SS03022WS	SS	AM-241	DUP	SS03021WS	0.2090	0.2510	0.0420	18
RA011	SS03022WS	SS	U-235	DUP	SS03021WS	0.0594	0.0176	0.0418	109
RA031	SS03051WS	SS	U-235	DUP	SS03050WS	0.0220	0.0580	0.0360	90
RA015	SS03031WS	SS	PU239/40	DUP	SS03030WS	0.1945	0.2249	0.0304	14
RA011	SS03025WS	SS	AM-241	DUP	SS03024WS	0.2265	0.2524	0.0259	11
RA011	SS03022WS	SS	URANIUM-233,-234	DUP	SS03021WS	0.8550	0.8350	0.0200	2
RA011	SS03022WS	SS	U-235	DUP	SS03021WS	0.0343	0.0176	0.0167	64
RA011	SS03025WS	SS	U-235	DUP	SS03024WS	0.0395	0.0523	0.0128	28
RA015	SS03031WS	SS	PU239/40	DUP	SS03030WS	0.2145	0.2249	0.0104	5
RA031	SS03051WS	SS	AM-241	DUP	SS03050WS	0.5440	0.5370	0.0070	1
RA015	SS03031WS	SS	AM-241	DUP	SS03030WS	0.0553	0.0598	0.0045	8
RA011	SS03025WS	SS	U-238DA	DUP	SS03024WS	0.9947	0.9987	0.0040	0
RA011	SS03022WS	SS	PU239/40	DUP	SS03021WS	1.0640	1.0630	0.0010	0

Table 4-2.
OU-2 PHASE II RFI/RI
CDH-Method Surface Soils

Plot	QC Sample ID	Media	Detected Analyte	QC Sample Type	Associated Real Sample	QC Sample Result	Real Sample Result	DELTA (pCi/g)	RPD Value (%)	VAL
PT045	SS80011WCU2	SS	PU239/40	DUP	SS00099WCU2	120.5000	154.3000	33.8	25	A
PT058	SS80005WCU2	SS	PU-239,240	DUP	SS00061WCU2	13.8570	5.0150	8.8	**-94**	**A**
PT045	SS80011WCU2	SS	AM-241	DUP	SS00099WCU2	19.7200	26.3400	6.6	29	A
PT044	SS80007WCU2	SS	PU-239,240	DUP	SS00081WCU2	26.5450	21.9250	4.6	-19	A
PT066	SS80009WCU2	SS	PU-239,240	DUP	SS00090WCU2	30.7840	29.2570	1.5	-5	A
PT044	SS80007WCU2	SS	AM-241	DUP	SS00081WCU2	4.3980	5.8400	1.4	28	V
PT044	SS80007WCU2	SS	U-233,234	DUP	SS00081WCU2	2.0100	3.4400	1.4	**52**	**A**
PT066	SS80009WCU2	SS	U-238	DUP	SS00090WCU2	3.7100	2.6400	1.1	-34	A
PT031	SS80013WCU2	SS	PU239/40	DUP	SS00108WCU2	22.3400	23.3900	1.1	5	JA
PT106	SS80001WCU2	SS	PU239/40	DUP	SS00009WCU2	10.7100	11.5000	.8	7	V
PT066	SS80009WCU2	SS	AM-241	DUP	SS00090WCU2	5.2750	5.9550	.7	12	A
PT044	SS80007WCU2	SS	U-238	DUP	SS00081WCU2	1.9400	2.5400	.6	27	A
PT066	SS80009WCU2	SS	U-233,234	DUP	SS00090WCU2	2.5300	2.0500	.5	-21	A
PT045	SS80011WCU2	SS	URANIUM-233,-234	DUP	SS00099WCU2	1.5790	1.2530	.3	-23	A
PT045	SS80011WCU2	SS	U238	DUP	SS00099WCU2	1.6300	1.9200	.3		R
PT045	SS80011WCU2	SS	U-238DA	DUP	SS00099WCU2	2.1160	1.8450	.3	-14	A
PT031	SS80013WCU2	SS	U238	DUP	SS00108WCU2	0.7010	0.5230	.2		R
PT045	SS80011WCU2	SS	AM241	DUP	SS00099WCU2	0.1820	0.3070	.1		**R**
PT031	SS80013WCU2	SS	URANIUM-233,-234	DUP	SS00108WCU2	1.2150	1.1030	.1	-10	A
PT031	SS80013WCU2	SS	AM241	DUP	SS00108WCU2	0.2850	0.1810	.1		**R**
PT044	SS80007WCU2	SS	U-235	DUP	SS00081WCU2	0.0900	0.1900	.1	**71**	**A**
PT031	SS80013WCU2	SS	AM-241	DUP	SS00108WCU2	3.3260	3.4140	.1	3	A
PT106	SS80001WCU2	SS	AM-241	DUP	SS00009WCU2	2.3030	2.3790	.1	3	A
PT031	SS80013WCU2	SS	U235	DUP	SS00108WCU2	0.0640	0.0000	.1		**R**
PT058	SS80005WCU2	SS	AM-241	DUP	SS00061WCU2	0.9270	0.8770	.1	-6	V
PT045	SS80011WCU2	SS	U235	DUP	SS00099WCU2	0.2210	0.1790	.		R
PT045	SS80011WCU2	SS	U-235	DUP	SS00099WCU2	0.1058	0.0656	.	**-47**	**A**
PT031	SS80013WCU2	SS	U-238DA	DUP	SS00108WCU2	1.2370	1.2050	.	-3	A
PT116	SS80003WCU2	SS	PU239/40	DUP	SS00015WCU2	0.0940	0.1194	.	24	V
PT066	SS80009WCU2	SS	U-235	DUP	SS00090WCU2	0.1300	0.1100	.	-17	A
PT116	SS80003WCU2	SS	AM-241	DUP	SS00015WCU2	0.0351	0.0435	.	21	A
PT031	SS80013WCU2	SS	U-235	DUP	SS00108WCU2	0.0667	0.0713	.	7	A

Table 4-3.
OU-2 PHASE II RFI/RI
RFP-Method Surficial Soils
PRECISION RESULTS

Plot	QC Sample ID	Media	Detected Analyte	QC Sample Type	Associated Real Sample	QC Sample Result	Real Sample Result	DELTA (pCi/g)	RPD Value (%)	VAL
PT028	SS00806STU2	SS	PU-239,240	DUP	SS00805STU2	11,000.0000	380	10,620.0000	**-187**	**A**
PT086	SS00737STU2	SS	PU-239,240	DUP	SS00736STU2	1.5030	8.743	7.2400	**141**	**A**
PT096	SS01117ST	SS	PU239/40	DUP	SS01116ST	1.6910	8.448	6.7570	**133**	**A**
PT068	SS00800STU2	SS	PU-239,240	DUP	SS00799STU2	29.0000	23	6.0000	-23	V
PT089	SS01140ST	SS	PU-239,240	DUP	SS01120ST	3.4600		3.4600		A
PT122	SS00749STU2	SS	PU-239,240	DUP	SS00748STU2	4.4740	2.262	2.2120	**-66**	**A**
PT058	SS01166ST	SS	PU-239,240	DUP	SS01165ST	6.2970	4.392	1.9050	-36	A
PT072	SS01130ST	SS	PU239/40	DUP	SS01129ST	13.1700	11.58	1.5900	-13	A
PT068	SS00800STU2	SS	AM-241	DUP	SS00799STU2	5.1000	4.3	0.8000	-17	A
PT089	SS01140ST	SS	AM-241	DUP	SS01120ST	0.4301		0.4301		A
PT058	SS01166ST	SS	AM-241	DUP	SS01165ST	0.9090	0.4869	0.4221	**-60**	**A**
PT011	SS00773STU2	SS	PU-239,240	DUP	SS00772STU2	0.5970	0.27	0.3270	**-75**	**V**
PT086	SS00737STU2	SS	AM-241	DUP	SS00736STU2	1.1090	0.9303	0.1787	-18	A
PT122	SS00749STU2	SS	AM-241	DUP	SS00748STU2	0.5031	0.3948	0.1083	-24	A
PT096	SS01117ST	SS	AM-241	DUP	SS01116ST	0.2684	0.3733	0.1049	33	A
PT122	SS00749STU2	SS	AM-241	DUP	SS00748STU2	0.4240	0.33	0.0940	-25	
PT083	SS00761STU2	SS	PU-239,240	DUP	SS00760STU2	1.4880	1.427	0.0610	-4	
PT083	SS00761STU2	SS	AM-241	DUP	SS00760STU2	0.1190	0.175	0.0560	38	
PT122	SS00749STU2	SS	AM-241	DUP	SS00748STU2	0.2580	0.224	0.0340	-14	
PT072	SS01130ST	SS	AM-241	DUP	SS01129ST	2.0970	2.069	0.0280	-1	A
PT104	SS01135ST	SS	PU-239,240	DUP	SS01134ST	2.9180	2.939	0.0210	1	A
PT011	SS00773STU2	SS	AM-241	DUP	SS00772STU2	0.0400	0.058	0.0180	37	V
PT104	SS01135ST	SS	AM-241	DUP	SS01134ST	0.4597	0.4717	0.0120	3	A
PT083	SS00761STU2	SS	AM-241	DUP	SS00760STU2	0.1970	0.185	0.0120	-6	A
PT083	SS00761STU2	SS	AM-241	DUP	SS00760STU2	0.1797	0.1685	0.0112	-6	

Overall, the RPD of less than or equal to 40% for duplicate samples was met for 85% of the duplicates collected by the CDH method. Uranium isotopic results for duplicate samples from plots 58, 106, and 116 were not located in RFEDS.

OU2 Phase II RFI/RI - RF Sampling Method

Duplicate Results

Analyte	Medium	Required RPD Value	Total Real Samples Collected	Total Duplicates Collected	Number of Duplicates within RPD	Overall Precision Compliance
Pu-239/240	Soil	≤ 40%	107	11	5	45%
Am-241	Soil	≤ 40%	107	11	10	91%

QA/QC sample collection requirements were met for both plutonium-239/240 and americium 241 in support of the RFP sampling program. However, no real sample results could be located for duplicate samples collected at Plot PT089 sample number SS01120ST. Overall, 68% of duplicate sample results were within the specified RPD range. At least 85% of all quality control samples were required to comply with the established precision, or RPD goals. This evaluation of duplicate sample results indicates that the Pu-239/240 and Am-241 values determined from samples collected using the RFP method do not meet the minimum requirements of DQOs for precision.

4.1.3 SOIL PROFILE DATA

Consistent with the OU-2 Work Plan, the DQO for field duplicate samples was ≤40% RPD for homogenous, non-aqueous samples. Summary results are provided below, while absolute and delta value are shown in Table 4-4, where values are sorted by the absolute difference ("delta) in results and in descending order.

OU2 Phase II RFI/RI - Soil Profile Program
Duplicate Results

Analyte	Medium	Required RPD Value	Total Real Samples Collected	Total Duplicates Collected	Number of Duplicates within RPD	Overall Precision Compliance
Pu-239	Soil	≤ 40%	258	10	6	60%
Am-241	Soil	≤ 40%	257	10	3	30%
U-233/234	Soil	≤ 40%	268	10	7	70%
U-235	Soil	≤ 40%	266	10	1	10%
U-238	Soil	≤ 40%	268	10	8	80%

QA/QC sample collection requirements were not met for radionuclide samples collected in support of this program. Fourteen duplicate samples were required to be collected to meet the one duplicate per twenty real sample ratio. Duplicate and real sample results validated as rejected were not incorporated into the evaluation. Overall, 50% of duplicate sample results were within the specified RPD range. At least 85% of all quality control samples are required to comply with the established precision, or RPD goals.

Table 4-4.
TRENCH/PIT
SURFACE SOILS
PRECISION RESULTS

TRENCH	QC SAMPLE ID	Media	DETECTED ANALYTE	QC Sample Type	ASSOCIATED REAL SAMPLE	QC SAMPLE RESULT	Real Sample Result	DELTA (pCi/g)	RPD Value (%)
TR08	TR00333WCU2	Soil	PU239/40	DUP	TR00329WCU2	4440.0000	3356.0000	1084.00	28
TR08	TR00333WCU2	Soil	AM-241	DUP	TR00329WCU2	1333.0000	1137.0000	196.000	16
TR20	**TR00061WCU2**	Soil	**PU239/240**	DUP	**TR00060WCU2**	**1.0800**	**1.9700**	0.8900	**58**
TR02	TR00398WCU2	Soil	PU239/40	DUP	TR00397WCU2	0.5649	1.2790	0.7141	**77**
TR18	TR00096WCU2	Soil	PU239/240	DUP	**TR00095WCU2**	2.3562	2.9400	0.5838	22
TR18	**TR00096WCU2**	Soil	**U-233/234**	DUP	**TR00095WCU2**	**0.4502**	**0.9110**	0.4608	**68**
TR23	**TR00040WCU2**	Soil	**Am241**	DUP	**TR00039WCU2**	**0.0000**	**0.4200**	0.4200	**200**
TR02	TR00394WCU2	Soil	U-233/234	DUP	TR00393WCU2	1.1760	0.8159	0.3601	36
TR23	**TR00040WCU2**	Soil	**PU239/240**	DUP	**TR00039WCU2**	**0.8450**	**0.5060**	0.3390	**50**
TR23	**TR00040WCU2**	Soil	**U-233/234**	DUP	TR00039WCU2	**0.4310**	**0.1210**	0.3100	**112**
TR12	TR00261WCU2	Soil	PU239/40	DUP	TR00260WCU2	0.4360	0.1633	0.2727	**91**
TR20	**TR00061WCU2**	Soil	**U238**	DUP	**TR00060WCU2**	**0.5988**	**0.3280**	0.2708	**58**
TR14	TR00249WCU2	Soil	U-233/234	DUP	TR00248WCU2	0.9117	1.1700	0.2583	25
TR14	TR00249WCU2	Soil	PU239/40	DUP	TR00248WCU2	5.4730	5.7010	0.2280	4
TR12	TR00259WCU2	Soil	U-233/234	DUP	TR00258WCU2	0.3366	0.5615	0.2249	**50**
TR14	TR00249WCU2	Soil	U-238DA	DUP	TR00248WCU2	0.6672	0.8772	0.2100	27
TR25	TR00232WCU2	Soil	U-233/234	DUP	TR00231WCU2	1.4730	1.2660	0.2070	15
TR02	TR00394WCU2	Soil	U-238DA	DUP	TR00393WCU2	1.3080	1.1110	0.1970	16
TR12	TR00261WCU2	Soil	U-238DA	DUP	TR00260WCU2	0.5333	0.7254	0.1921	31
TR08	TR00333WCU2	Soil	U-233/234	DUP	TR00329WCU2	6.9760	6.7960	0.1800	3
TR18	**TR00096WCU2**	Soil	**U238**	DUP	**TR00095WCU2**	**0.5145**	**0.6665**	0.1520	**26**
TR20	TR00061WCU2	Soil	U-233/234	DUP	**TR00060WCU2**	0.5290	**0.3940**	0.1350	**29**
TR08	TR00333WCU2	Soil	U-238DA	DUP	TR00329WCU2	10.6700	10.5500	0.1200	1
TR25	TR00232WCU2	Soil	PU239/40	DUP	**TR00231WCU2**	0.3732	0.2577	0.1155	37
TR18	**TR00096WCU2**	Soil	**AM241**	DUP	**TR00095WCU2**	**0.5307**	0.4250	0.1057	**22**
TR25	TR00232WCU2	Soil	U-238DA	DUP	TR00231WCU2	1.5060	1.6040	0.0980	6
TR02	TR00398WCU2	Soil	U-233/234	DUP	TR00397WCU2	0.8607	0.9566	0.0959	11

Table 4-4.
TRENCH/PIT
SURFACE SOILS
PRECISION RESULTS

TRENCH	QC SAMPLE ID	Media	DETECTED ANALYTE	QC Sample Type	ASSOCIATED REAL SAMPLE	QC SAMPLE RESULT	Real Sample Result	DELTA (pCi/g)	RPD Value (%)
TR23	**TR00040WCU2**	Soil	**U238**	DUP	TR00039WCU2	**0.3260**	**0.2420**	0.0840	**30**
TR12	TR00259WCU2	Soil	U-238DA	DUP	TR00258WCU2	0.8386	0.7570	0.0816	10
TR20	**TR00061WCU2**	Soil	**U235**	DUP	**TR00060WCU2**	**0.0420**	**0.1220**	0.0800	**98**
TR08	TR00333WCU2	Soil	U-235	DUP	TR00329WCU2	1.8430	1.7660	0.0770	4
TR12	TR00259WCU2	Soil	PU239/40	DUP	TR00258WCU2	0.1693	0.2425	0.0732	36
TR02	TR00398WCU2	Soil	AM-241	DUP	TR00397WCU2	0.0738	0.1418	0.0680	**63**
TR20	**TR00061WCU2**	Soil	**AM241**	DUP	**TR00060WCU2**	**0.1000**	**0.1680**	0.0680	**51**
TR14	TR00249WCU2	Soil	U-235	DUP	TR00248WCU2	0.0660	-0.0009	0.0669	**206**
TR02	TR00398WCU2	Soil	U-238DA	DUP	TR00397WCU2	1.1310	1.0780	0.0530	5
TR02	TR00394WCU2	Soil	U-235	DUP	TR00393WCU2	0.0310	0.0773	0.0463	**86**
TR12	TR00261WCU2	Soil	AM-241	DUP	TR00260WCU2	0.0769	0.0353	0.0416	**74**
TR14	TR00249WCU2	Soil	AM-241	DUP	TR00248WCU2	0.9106	0.9518	0.0412	4
TR14	TR00249WCU2	Soil	AM-241	DUP	TR00248WCU2	1.1980	1.2370	0.0390	3
TR23	TR00040WCU2	Soil	PU239/240	DUP	**TR00039WCU2**	0.0721	0.0380	0.0341	**62**
TR25	**TR00232WCU2**	Soil	**AM-241**	DUP	TR00231WCU2	**0.0888**	**0.0564**	0.0324	**45**
TR12	TR00261WCU2	Soil	U-235	DUP	TR00260WCU2	0.0432	0.0691	0.0259	**46**
TR23	**TR00040WCU2**	Soil	**U235**	DUP	TR00039WCU2	**0.0240**	**0.0000**	0.0240	**200**
TR23	TR00040WCU2	Soil	U-235	DUP	**TR00039WCU2**	0.0000	0.0221	0.0221	**200**
TR12	TR00259WCU2	Soil	AM-241	DUP	TR00258WCU2	0.0284	0.0504	0.0220	**56**
TR12	TR00259WCU2	Soil	U-235	DUP	TR00258WCU2	0.0153	0.0355	0.0202	**80**
TR12	TR00261WCU2	Soil	U-233/234	DUP	TR00260WCU2	0.5333	0.5147	0.0186	4
TR18	**TR00096WCU2**	Soil	**U235**	DUP	**TR00095WCU2**	**0.0150**	**0.0000**	0.0150	**200**
TR02	TR00398WCU2	Soil	U-235	DUP	TR00397WCU2	0.0112	0.0000	0.0112	**200**
TR25	TR00232WCU2	Soil	U-235	DUP	TR00231WCU2	0.0102	0.0000	0.0102	**200**
TR23	TR00040WCU2	Soil	U-233/234	DUP	TR00039WCU2	0.2135	0.2210	0.0075	3
TR02	TR00394WCU2	Soil	AM-241	DUP	TR00393WCU2	0.0056	0.0129	0.0073	**79**
TR02	TR00394WCU2	Soil	PU239/40	DUP	TR00393WCU2	0.0311	0.0238	0.0073	27
TR23	TR00040WCU2	Soil	U-238	DUP	TR00039WCU2	0.1660	0.1620	0.0040	2
TR23	TR00040WCU2	Soil	AM241	DUP	**TR00039WCU2**	0.0089	0.0067	0.0022	28

4.2 ACCURACY

In general, accuracy of the radiochemical analyses, for all subsets of samples evaluated, was satisfactory based on:

- The percentage of sample results validated;
- The percentage of validated sample results that were acceptable (not rejected);
- Consistency and magnitude of detections limits as compared with RFCA Tier I Action Levels (reporting limits were typically 3 to 4 orders of magnitude less than action levels); and
- relatively low to nondetected values of radionuclides in field blank samples (specifically field rinsates) associated with the real environmental samples, indicating insignificant bias of real samples toward false positive results.

Reporting limits for radionuclides in water samples (per GRRASP specifications {DOE/EG&G Rocky Flats, 1994}) range from 0.01 pCi/L (Pu, Am) to 0.6 pCi/L (U), and were only used qualitatively to compare with soil samples, which are measured in different units (pCi/g).

4.2.1 OU-1 PHASE III RFI/RI DATA

Analytical methods performed on samples were performed utilizing alpha spectroscopy methods as outlined in the General Radiochemistry and Routine Analytical Services Protocol (GRRASP, DOE/EG&G Rocky Flats, 1994). Methods proposed in OU1 TM5 included EPA analytical methods and additional published methods. The reason for the revision in analytical program is not documented in the OU1 Phase III RFI/RI Report. However, the proposed method detection limits and GRRASP (ibid.) detection limits are identical. Results tabulated below indicate that actual detection limits were well within contractual specifications given to the labs, as well as significantly less than RFCA action levels.

OU1 Phase III RFI/RI - Soil Sampling Program
Detection Limits

Analyte	Required Analytical Method[1]	Actual Analytical Method	Required Detection Limit (pCi/g)	GRRASP Detection Limit (pCi/g)	Actual Detection Limit (pCi/g)
Pu-239/240	i, j	GRRASP Part B Alpha Spec	0.03	0.03	≤0.02
Am-241	j, k	GRRASP Part B Alpha Spec	0.02	0.02	≤0.014
U-233/234	a, c, d, g, h	GRRASP Part B Alpha Spec	0.3	0.3	≤0.060
U-235	a, c, d, g, h	GRRASP Part B Alpha Spec	0.3	0.3	≤0.053
U-238	a, c, d, g, h	GRRASP Part B Alpha Spec	0.3	0.3	≤0.050

a. Harley, J.H., ed., 1975. HASL Procedures Manual, HASL-300: Washington, DC, U.S. Energy Research and Development Administration.
c. U.S. EPA, 1976. Interim Radiochemical Methodology for Drinking Water, Report No. EPA-600/4-75-008.

d. U.S. EPA, 1979. Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LY-0539-1, Las Vegas, NV. U.S. Environmental Protection Agency. Cincinnati, OH. U.S. Environmental Protection Agency.
g. "Methods for Determination of Radioactive Substance in Water and Fluvial Sediment", U.S.G.S. Book A5, 1977.
h. U.S. EPA, 1979. Acid Dissolution Method for the Analysis of Plutonium-Plutonium-239/240 in Soils. EPA-600/7-79-081. U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, NV.
i. Essington, E.H., Drennon, B.J., Private Conversation. Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium-Plutonium-239/240, Uranium, and Americium. Los Alamos National Laboratories.
j. Rocky Flats Plant. Health, Safety, and Environmental Laboratories. Isolation of Plutonium-239/240 from Urine Samples.
k. U.S. EPA. EPA-570/9-81-002, Radioactivity in Drinking Water.

Blank samples associated with the real samples must also be evaluated to determine if accuracy was affected (biased toward false positives) by cross-contamination during sampling or shipment; specifically, rinsate samples were used for this purpose. Although magnitudes of radioactivity can only be compared indirectly between the rinsate results and the real (soil) sample results -- due to different matrix types -- results indicate only very low levels of activity (<0.2pCi/L), well within the overall precision of the soil sample measurements. Therefore, no significant cross-contamination is evident, from decontamination procedures or otherwise, which would bias the real sample results toward false positive values. Results of rinsates, sorted from highest to lowest values, are given in Table 4-5.

4.2.2 OU-2 PHASE II RFI/RI DATA

The OU2 QAA identified EPA and other published laboratory methods for the determination of radionuclides in surface soil samples. The samples were analyzed utilizing alpha spectroscopy according to the General Radiochemistry and Routine Analytical Services Protocol (GRRASP, 1991). The GRRASP method has identical detection limits (0.03 pCi/g) for plutonium-239/240 and a slightly higher detection limit (0.02 pCi/g) for americium-241. GRRASP detection limits for uranium isotopes are one order of magnitude higher (0.3 pCi/g) than proposed (0.06 pCi/g) but are acceptable for the determination of spatial extent of contamination at the RFETS. Results tabulated below indicate that detection limits are at or below those required in the GRRASP, with the exception of plutonium and americium; however, exceedances of this magnitude are insignificant relative to RFCA cleanup levels.

OU2 Phase II RFI/RI - CDH Sampling Method
Detection Limits

Analyte	Required Analytical Method[2]	Actual Analytical Method	Required Detection Limit (pCi/g)	GRRASP Detection Limit (pCi/g)	Actual Detection Limit (pCi/g)
Pu-239/240	i, l, o, p, s	GRRASP Part B Alpha Spec	0.03	0.03	≤0.244
Am-241	i, l, p, q, s	GRRASP Part B Alpha Spec	0.01	0.02	≤0.287
U-233/234	f, h, i, l, m, n, s	GRRASP Part B Alpha Spec	0.06	0.3	≤0.077
U-235	f, h, i, l, m, n, s	GRRASP Part B Alpha Spec	0.06	0.3	≤0.300
U-238	f, h, i, l, m, n, s	GRRASP Part B Alpha Spec	0.06	0.3	≤0.300

Table 4-5.
OU-1 PHASE III RFI/RI
SURFICIAL SOILS
RINSATE DATA

LOC	QC	SAMPLE	SAMPLE DATE	ANALYTE	QA SAMPLE RESULT	UNITS	QC VAL
RA031	RNS	SS03052WS	03-MAR-92	URANIUM-233,-234	0.1224	PCI/L	A
RA011	RNS	SS03023WS	27-FEB-92	U-238DA	0.0190	PCI/L	A
RA031	RNS	SS03052WS	03-MAR-92	PU239/40	0.0056	PCI/L	A
RA011	RNS	SS03023WS	27-FEB-92	AM-241	0.0046	PCI/L	A
RA031	RNS	SS03052WS	03-MAR-92	AM-241	0.0016	PCI/L	A
RA011	RNS	SS03023WS	27-FEB-92	PU239/40	0.0014	PCI/L	A
RA011	RNS	SS03023WS	27-FEB-92	U-235	-0.0069	PCI/L	A
RA031	RNS	SS03052WS	03-MAR-92	U-238DA	-0.0069	PCI/L	A
RA031	RNS	SS03052WS	03-MAR-92	U-235	-0.0103	PCI/L	A
RA011	RNS	SS03023WS	27-FEB-92	URANIUM-233,-234	-0.0173	PCI/L	A

Partner sample identification and sample dates not provided from RFEDS.

f U.S. EPA, 1979. Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LY-0539-1, Las Vegas, NV. U.S. Environmental Protection Agency.
h U.S. EPA, 1976. Interim Radiochemical Methodology for Drinking Water, Report No. EPA-600/4-75-008. Cincinnati, OH. U.S. Environmental Protection Agency.
i Harley, J.H., ed., 1975. ASL Procedures Manual, HASL-300: Washington, DC, U.S. Energy Research and Development Administration.
l U.S. EPA, August 1980. Prescribed Procedures for Measurement of Radioactivity in Drinking Water. Environmental Monitoring and Support Laboratory. Office of Research and Development.
m U.S. Geological Survey, 1977. Book 5. Methods for Determination of Radioactive Substances in Water and Fluvial Sediments.
n U.S. EPA, 1979. Acid Dissolution Method for the Analysis of Plutonium-Plutonium-239/240 in Soils. EPA-600/7-79-081. U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, NV.
o Essington, E.H., Drennon, B.J., Private Conversation. Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium-Plutonium-239/240, Uranium, and Americium. Los Alamos National Laboratories.
p Rocky Flats Plant. Health, Safety, and Environmental Laboratories. Isolation of Plutonium-Plutonium-239/240 from Urine Samples.
q U.S. EPA. EPA-570/9-81-002, Radioactivity in Drinking Water.
s U.S. EPA, 1987. EPA-520/5-84-006. Eastern Environmental Radiation Facility Radiochemistry Procedures Manual.

The OU2 QAA states that equipment rinsate blanks are considered acceptable if the concentration of the analytes of interest is less than three times the required detection limit for the analyte. However, this strategy is not consistent with the Risk Assessment Guidance for Superfund (RAGS, 1989). RAGS states that if the contaminant is not a common laboratory contaminant then "*consider site sample results as positive only if the concentration of the chemical in the site sample exceeds five times the maximum amount detected in any blank.*". Rinsate samples were evaluated according to the RAGS guidance for this effort.

Analytical methods performed on samples collected utilizing the CDH method were performed utilizing alpha spectroscopy methods as outlined in the General Radiochemistry and Routine Analytical Services Protocol (GRRASP). Methods proposed in the OU2 QAA included EPA analytical methods and additional published methods. The reason for the revision in analytical program is not documented in the OU2 Phase II RFI/RI Report. Based on validation percentages and reporting limits, the various radiochemistry methods are comparable.

Blank samples associated with the real samples were also evaluated to determine if accuracy was affected (biased toward false positives) by cross-contamination during sampling or shipment; specifically, rinsate samples were used for this purpose. Although magnitudes of radioactivity can only be compared indirectly between the rinsate results and the real (soil) sample results – due to different matrix types – rinsate results indicate only very low levels of activity (<0.14pCi/L), well within the overall precision of the soil sample measurements. Therefore, no significant cross-contamination is evident, from decontamination procedures or otherwise, which would bias the real sample results toward false positive values. Results of rinsates, sorted from highest to lowest values, are given in Table 4-6.

Although not specified in the OU2 Work Plan the surface soils collected by the RFP method in support of the Phase II RFI/RI are required to follow the protocols identified in the OU2 QAA.

Sample analyses was performed according to the GRRASP. The GRRASP detection limits for Pu and Am-241 are similar to the detection limits proposed in the OU2 Work Plan and considered acceptable analytical methods. Results tabulated below indicate that detection limits exceed those required in the GRRASP; however, exceedances of this magnitude are insignificant relative to RFCA cleanup levels (2

Table 4-6.
CDH-METHOD (OU-2)
SURFICIAL SOIL
RINSATE RESULTS

LOCATION	QC	SAMPLE	SAMPLE DATE	ANALYTE	QC Sample Result	UNITS	VAL
PT045	RNS	SS80012WCU2	13-AUG-91	URANIUM-233,-234	0.1428	PCI/L	A
PT031	RNS	SS80014WCU2	14-AUG-91	U-238DA	0.0885	PCI/L	A
PT031	RNS	SS80014WCU2	14-AUG-91	URANIUM-233,-234	0.0885	PCI/L	A
PT045	RNS	SS80012WCU2	13-AUG-91	AM-241	0.0161	PCI/L	A
PT106	RNS	SS80002WCU2	09-JUL-91	AM-241	0.0101	PCI/L	V
PT044	RNS	SS80008WCU2	08-AUG-91	AM-241	0.0100	PCI/L	V
PT058	RNS	SS80006WCU2	30-JUL-91	AM-241	0.0060	PCI/L	V
PT066	RNS	SS80010WCU2	09-AUG-91	PU-239,240	0.0060	PCI/L	V
PT031	RNS	SS80014WCU2	14-AUG-91	PU239/40	0.0055	PCI/L	A
PT116	RNS	SS80004WCU2	10-JUL-91	AM-241	0.0049	PCI/L	V
PT066	RNS	SS80010WCU2	09-AUG-91	AM-241	0.0030	PCI/L	V
PT031	RNS	SS80014WCU2	14-AUG-91	AM-241	0.0025	PCI/L	A
PT044	RNS	SS80008WCU2	08-AUG-91	PU-239,240	0.0010	PCI/L	V
PT106	RNS	SS80002WCU2	09-JUL-91	PU239/40	0.0003	PCI/L	V
PT058	RNS	SS80006WCU2	30-JUL-91	PU-239,240	0.0000	PCI/L	V
PT045	RNS	SS80012WCU2	13-AUG-91	PU239/40	-0.0006	PCI/L	A
PT116	RNS	SS80004WCU2	10-JUL-91	PU239/40	-0.0007	PCI/L	V
PT031	RNS	SS80014WCU2	14-AUG-91	U-235	-0.0080	PCI/L	A
PT045	RNS	SS80012WCU2	13-AUG-91	U-235	-0.0204	PCI/L	A
PT045	RNS	SS80012WCU2	13-AUG-91	U-238DA	-0.0204	PCI/L	A

orders of magnitude less than Tier I action levels).

OU2 Phase II RFI/RI - RFP Sampling Method Detection Limits

Analyte	Required Analytical Method[1]	Actual Analytical Method	Required Detection Limit (pCi/g)	GRRASP Detection Limit (pCi/g)	Actual Detection Limit (pCi/g)
Pu-	i, l, o, p, s	GRRASP Part B, Alpha Spec	0.03	0.03	≤2.30
Am-241	i, l, p, q, s	GRRASP Part B, Alpha Spec	0.01	0.02	≤5.7290

Blank samples associated with the real samples must also be evaluated to determine if accuracy was affected (biased toward false positives) by cross-contamination during sampling or shipment; specifically, rinsate samples were used for this purpose. Although magnitudes of radioactivity can only be compared indirectly between the rinsate results and the real (soil) sample results -- due to different matrix types -- rinsate results indicate only very low levels of activity (<0.12pCi/L), well within the overall precision of the soil sample measurements. Therefore, no significant cross-contamination is evident, from decontamination procedures or otherwise, which would bias the real sample results toward false positive values. Results of rinsates, sorted from highest to lowest values, are given in Table 4-7.

4.2.3 SOIL PROFILE DATA

Analytical methods performed on samples collected utilizing under the trench program were performed utilizing alpha spectroscopy methods as outlined in the General Radiochemistry and Routine Analytical Services Protocol (GRRASP). Methods proposed in the OU2 QAA included EPA analytical methods and additional published methods. The reason for the revision in analytical program is not documented in the OU2 Phase II RFI/RI Report. Results tabulated below indicate that detection limits exceed those required in the GRRASP; however, exceedances of this magnitude are insignificant relative to RFCA cleanup levels (2 orders of magnitude less than Tier I action levels).

OU2 Phase II RFI/RI - Soil Profile Sampling Program Detection Limits

Analyte	Required Analytical Method[3]	Actual Analytical Method	Required Detection Limit (pCi/g)	GRRASP Detection Limit (pCi/g)	Actual Detection Limit (pCi/g)
Pu-239/240	i, l, o, p, s	GRRASP Part B Alpha Spec	0.03	0.03	≤2.000
Am-241	i, l, p, q, s	GRRASP Part B Alpha Spec	0.01	0.02	≤3.000
U-233/234	f, h, i, l, m, n, s	GRRASP Part B Alpha Spec	0.06	0.3	≤1.860
U-235	f, h, i, l, m, n, s	GRRASP Part B Alpha Spec	0.06	0.3	≤0.945
U-238	f, h, i, l, m, n, s	GRRASP Part B Alpha Spec	0.06	0.3	≤1.320

Table 4-7.
RFP-METHOD (OU-2)
SURFICAL SOILS
RINSATE RESULTS

Location	Type	Sample	Sample Date	Analyte	QC Sample Result	Units	Val
PT011	RNS	SS00774STU2	14-OCT-91	Plutonium 239/240	0.0040	PCI/L	V
PT011	RNS	SS00774STU2	14-OCT-91	AM-241	0.0030	PCI/L	A
PT019	RNS	SS00808STU2	27-NOV-91	Plutonium 239/240	0.1200	PCI/L	A
PT019	RNS	SS00808STU2	27-NOV-91	Americium 241	0.0430	PCI/L	V
PT020	RNS	SS00803STU2	27-NOV-91	Plutonium 239/240	0.0650	PCI/L	A
PT020	RNS	SS00803STU2	27-NOV-91	Americium 241	0.0120	PCI/L	V
PT020	RNS	SS00803STU2	27-NOV-91	Americium 241	0.0090	PCI/L	V
PT083	RNS	SS00762STU2	11-OCT-91	Plutonium 239/240	0.0010	PCI/L	V
PT083	RNS	SS00762STU2	11-OCT-91	AM-241	-0.0020	PCI/L	A
PT086	RNS	SS00738STU2	08-OCT-91	PU-239,240	0.0420	PCI/L	V
PT086	RNS	SS00738STU2	08-OCT-91	AM-241	0.0190	PCI/L	V
PT089	RNS	SS01141ST	11-NOV-92	PU239/40	0.0033	PCI/L	A
PT089	RNS	SS01141ST	11-NOV-92	AM-241	0.0027	PCI/L	A
PT104	RNS	SS01136ST	11-NOV-92	Am-241	0.0024	PCI/L	A
PT104	RNS	SS01136ST	11-NOV-92	Pu-239/40	0.0000	PCI/L	A
PT122	RNS	SS00750STU2	10-OCT-91	AM-241	0.0050	PCI/L	V
PT122	RNS	SS00750STU2	10-OCT-91	PU-239,240	0.0020	PCI/L	V

f U.S. EPA, 1979. Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LY-0539-1, Las Vegas, NV. U.S. Environmental Protection Agency.
h U.S. EPA, 1976. Interim Radiochemical Methodology for Drinking Water, Report No. EPA-600/4-75-008. Cincinnati, OH. U.S. Environmental Protection Agency.
i Harley, J.H., ed., 1975. ASL Procedures Manual, HASL-300: Washington, DC, U.S. Energy Research and Development Administration.
l U.S. EPA, August 1980. Prescribed Procedures for Measurement of Radioactivity in Drinking Water. Environmental Monitoring and Support Laboratory. Office of Research and Development.
m U.S. Geological Survey, 1977. Book 5. Methods for Determination of Radioactive Substances in Water and Fluvial Sediments.
n U.S. EPA, 1979. Acid Dissolution Method for the Analysis of Plutonium-Plutonium-239/240 in Soils. EPA-600/7-79-081. U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, NV.
o Essington, E.H., Drennon, B.J., Private Conversation. Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium-Plutonium-239/240, Uranium, and Americium. Los Alamos National Laboratories.
p Rocky Flats Plant. Health, Safety, and Environmental Laboratories. Isolation of Plutonium-Plutonium-239/240 from Urine Samples.
q U.S. EPA. EPA-570/9-81-002, Radioactivity in Drinking Water.
s U.S. EPA, 1987. EPA-520/5-84-006. Eastern Environmental Radiation Facility Radiochemistry Procedures Manual.

Blank samples associated with the real samples must also be evaluated to determine if accuracy was affected (biased toward false positives) by cross-contamination during sampling or shipment; specifically, rinsate samples were used for this purpose. Although magnitudes of radioactivity can only be compared indirectly between the rinsate results and the real (soil) sample results -- due to different matrix types -- results indicate only very low levels of activity (<1pCi/L), well within the overall precision of the soil sample measurements. Therefore, no significant cross-contamination is evident, from decontamination procedures or otherwise, which would bias the real sample results toward false positive values. Results of rinsates, sorted from highest to lowest values, are given in Table 4-8.

4.3 COMPLETENESS

Completeness relative to previous work plan specifications was adequate. Completeness relative to the prospective OU-2 surficial soil remediation is indeterminate with this evaluation, and can only be determined when the "historical" data reviewed herein are compared with specific remediation objectives.

4.3.1 OU-1 PHASE III RFI/RI DATA

The data was downloaded from the RFEDS and was determined to be 72 percent validated prior to evaluating for usability according to this procedure.

4.3.1.1 REAL SAMPLES

A total of 34 surface soil samples were collected at 28 of the proposed 28 plots. The radiochemical analyses include gross alpha, gross beta, plutonium-239/240, americium-241, uranium-233/234, uranium-235, uranium-238, radium-226, and radium 228. As previously stated only results from the analysis of plutonium-239/240, americium-241, uranium-233/234, uranium-235, and uranium-238 will be evaluated.

Table 4-8.
TRENCH/PIT
SURFICIAL SOILS
RINSATE RESULTS

LOC	QC	SAMPLE	SAMPLE DATE	ANALYTE	QA SAMPLE RESULT	UNITS	QC VAL
TR03	RNS	TR00382WCU2	27-JUL-92	U-233,-234	0.9200	PCI/L	A
TR03	RNS	TR00382WCU2	27-JUL-92	U-238DA	0.8600	PCI/L	JA
TR22	RNS	TR00033WCU2	20-AUG-91	PU239/40	0.6800	PCI/L	
TR22	RNS	TR00033WCU2	20-AUG-91	AM241	0.6400	PCI/L	
TR08	RNS	TR00334WCU2	10-OCT-91	PU239/40	0.6087	PCI/L	V
TR20	RNS	TR00063WCU2	22-AUG-91	PU239/240	0.5300	PCI/L	
TR05	RNS	TR00368WCU2	13-JUL-92	U-233,-234	0.4500	PCI/L	A
TR01	RNS	TR00357WCU2	08-JUN-92	U-235	0.3300	PCI/L	A
TR03	RNS	TR00382WCU2	27-JUL-92	U-235	0.3090	PCI/L	A
TR01	RNS	TR00357WCU2	08-JUN-92	U-238DA	0.2330	PCI/L	JA
TR05	RNS	TR00368WCU2	13-JUL-92	U-238DA	0.2123	PCI/L	JA
TR03	RNS	TR00392WCU2	29-JUL-92	U-233,-234	0.1912	PCI/L	A
TR02	RNS	TR00405WCU2	10-AUG-92	PU239/40	0.1900	PCI/L	A
TR20	RNS	TR00063WCU2	22-AUG-91	AM241	0.1700	PCI/L	
TR07	RNS	TR00317WCU2	09-OCT-91	U-233,-234	0.1679	PCI/L	V
TR12	RNS	TR00268WCU2	25-SEP-91	U-233,-234	0.1475	PCI/L	A
TR05	RNS	TR00368WCU2	13-JUL-92	PU239/40	0.1400	PCI/L	A
TR08	RNS	TR00334WCU2	10-OCT-91	AM-241	0.1382	PCI/L	V
TR03	RNS	TR00392WCU2	29-JUL-92	U-238DA	0.1207	PCI/L	JA
TR26	RNS	TR00217WCU2	19-SEP-91	U-238DA	0.1135	PCI/L	A
TR20	RNS	TR00063WCU2	22-AUG-91	U-233,-234	0.1100	PCI/L	
TR05	RNS	TR00368WCU2	13-JUL-92	U-235	0.0966	PCI/L	A
TR17	RNS	TR00165WCU2	05-SEP-91	U238	0.0952	PCI/L	
TR22	RNS	TR00033WCU2	20-AUG-91	U-233,-234	0.0900	PCI/L	
TR01	RNS	TR00357WCU2	08-JUN-92	U-233,-234	0.0750	PCI/L	A
TR19	RNS	TR00149WCU2	04-SEP-91	U-233,-234	0.0732	PCI/L	A
TR19	RNS	TR00149WCU2	04-SEP-91	U-238DA	0.0732	PCI/L	A
TR10	RNS	TR00182WCU2	12-SEP-91	U-233,-234	0.0699	PCI/L	A
TR03	RNS	TR00382WCU2	27-JUL-92	PU239/40	0.0520	PCI/L	A
TR17	RNS	TR00165WCU2	05-SEP-91	Americium 2	0.0514	PCI/L	
TR20	RNS	TR00033WCU2	20-AUG-91	U-238	0.0500	PCI/L	
TR25	RNS	TR00234WCU2	23-SEP-91	U-233,-234	0.0477	PCI/L	A
TR09	RNS	TR00301WCU2	08-OCT-91	PU239/40	0.0459	PCI/L	A
TR02	RNS	TR00405WCU2	10-AUG-92	AM-241	0.0440	PCI/L	A
TR08	RNS	TR00334WCU2	10-OCT-91	U-238DA	0.0406	PCI/L	V
TR20	RNS	TR00063WCU2	22-AUG-91	U238	0.0400	PCI/L	
TR17	RNS	TR00165WCU2	05-SEP-91	U-233,-234	0.0381	PCI/L	
TR17	RNS	TR00165WCU2	05-SEP-91	Plutonium 2	0.0242	PCI/L	
TR05	RNS	TR00368WCU2	13-JUL-92	AM-241	0.0220	PCI/L	A
TR11	RNS	TR00285WCU2	26-SEP-91	PU239/40	0.0208	PCI/L	A
TR26	RNS	TR00217WCU2	19-SEP-91	U-233,-234	0.0206	PCI/L	A

Table 4-8.
TRENCH/PIT
SURFICIAL SOILS
RINSATE RESULTS

LOC	QC	SAMPLE	SAMPLE DATE	ANALYTE	QA SAMPLE RESULT	UNITS	QC VAL
TR12	RNS	TR00268WCU2	25-SEP-91	PU239/40	0.0196	PCI/L	A
TR03	RNS	TR00392WCU2	29-JUL-92	PU239/40	0.0180	PCI/L	A
TR19	RNS	TR00149WCU2	04-SEP-91	U-235	0.0122	PCI/L	A
TR10	RNS	TR00182WCU2	12-SEP-91	AM-241	0.0119	PCI/L	A
TR25	RNS	TR00234WCU2	23-SEP-91	U-238DA	0.0119	PCI/L	A
TR09	RNS	TR00301WCU2	08-OCT-91	AM-241	0.0104	PCI/L	A
TR26	RNS	TR00217WCU2	19-SEP-91	U-235	0.0103	PCI/L	A
TR03	RNS	TR00392WCU2	29-JUL-92	AM-241	0.0089	PCI/L	A
TR04	RNS	TR00423WCU2	25-AUG-92	AM-241	0.0079	PCI/L	A
TR07	RNS	TR00317WCU2	09-OCT-91	PU239/40	0.0077	PCI/L	V
TR10	RNS	TR00182WCU2	12-SEP-91	PU239/40	0.0070	PCI/L	A
TR14	RNS	TR00250WCU2	24-SEP-91	AM-241	0.0067	PCI/L	A
TR04	RNS	TR00423WCU2	25-AUG-92	PU239/40	0.0065	PCI/L	A
TR12	RNS	TR00268WCU2	25-SEP-91	AM-241	0.0061	PCI/L	A
TR03	RNS	TR00382WCU2	27-JUL-92	AM-241	0.0059	PCI/L	A
TR11	RNS	TR00285WCU2	26-SEP-91	AM-241	0.0053	PCI/L	A
TR07	RNS	TR00317WCU2	09-OCT-91	AM-241	0.0037	PCI/L	V
TR19	RNS	TR00149WCU2	04-SEP-91	AM-241	0.0036	PCI/L	A
TR24	RNS	TR00198WCU2	17-SEP-91	AM-241	0.0034	PCI/L	A
TR25	RNS	TR00234WCU2	23-SEP-91	PU239/40	0.0033	PCI/L	V
TR14	RNS	TR00250WCU2	24-SEP-91	PU239/40	0.0028	PCI/L	A
TR24	RNS	TR00198WCU2	17-SEP-91	PU239/40	0.0018	PCI/L	V
TR25	RNS	TR00234WCU2	23-SEP-91	AM-241	0.0015	PCI/L	A
TR01	RNS	TR00357WCU2	08-JUN-92	PU239/40	0.0013	PCI/L	A
TR19	RNS	TR00149WCU2	04-SEP-91	PU239/40	0.0013	PCI/L	V
TR26	RNS	TR00217WCU2	19-SEP-91	AM-241	0.0013	PCI/L	A
TR26	RNS	TR00217WCU2	19-SEP-91	PU239/40	0.0010	PCI/L	V
TR03	RNS	TR00392WCU2	29-JUL-92	U-235	0.0000	PCI/L	A
TR04	RNS	TR00423WCU2	25-AUG-92	U-235	0.0000	PCI/L	A
TR07	RNS	TR00317WCU2	09-OCT-91	U-235	0.0000	PCI/L	V
TR07	RNS	TR00317WCU2	09-OCT-91	U-238DA	0.0000	PCI/L	V
TR08	RNS	TR00334WCU2	10-OCT-91	U-233,-234	0.0000	PCI/L	V
TR09	RNS	TR00301WCU2	08-OCT-91	U-235	0.0000	PCI/L	A
TR09	RNS	TR00301WCU2	08-OCT-91	U-238DA	0.0000	PCI/L	A
TR10	RNS	TR00182WCU2	12-SEP-91	U-235	0.0000	PCI/L	A
TR12	RNS	TR00268WCU2	25-SEP-91	U-238DA	0.0000	PCI/L	A
TR14	RNS	TR00250WCU2	24-SEP-91	U-235	0.0000	PCI/L	A

Results for 34 "real" samples were downloaded from RFEDS for plutonium-239/240, indicating that 6 sites were sample twice. No samples exceeded the detection limit of 0.03 pCi/g. No plutonium-239/240 sample results were validated as rejected results. A plutonium-239/240 value was determined acceptable for each sample collected at all 28 plots (100%). The lower plutonium value for the plots with two results should be excluded for the usable data set.

Results for 34 "real" samples for americium-241were provided from RFEDS, indicating that 6 plots were sampled twice. No samples exceed the detection limit of 0.02 pCi/g for americium. Six sample results were validated as rejected results. Acceptable results for americium-241 are available for 24 of the 28 plots sampled (86%). The rejected results and lower americium value for the plots with two results should be excluded for the usable data set.

Results for 34 "real" samples for uranium-233/234, uranium-235, and uranium-238 were provided from RFEDS, indicating that 6 plots were sampled twice. No samples exceeded the detection limit of 0.3 pCi/g. No sample results were validated as rejected. Therefore, acceptable results for uranium isotopes are available for 28 of the 28 plots sampled (100%). The lower uranium value for the plots with two results should be excluded for the usable data set.

TM5 proposed the collection of surface soil samples at 28 plots for radiochemical analyses to include plutonium-239/240, americium-241, uranium-233/234, -235, and -238 for a total of 140 sample results. Validated data was provided for a total of 136 samples for 97% completion. TM5 states that the target completeness objective for both field and analytical data for this project are 90%.

4.3.1.2 QC SAMPLES

Overall, 95% of the required QA/QC analyses provided acceptable results.

A total of 4 duplicates were collected and analyzed for plutonium-239/240, americium 24, and uranium isotopes in support of the sampling program. These samples met the frequency requirements of 1 in 20 as required by the QA/QC section of TM5. Of the samples analyzed for plutonium-239/240, no analyses exceeded the detection limit of 0.03 pCi/g and no plutonium-239/240 sample results were validated as rejected. The samples were analyzed for americium, no analyses exceed the detection limit of 0.02 pCi/g. However, three samples were validated as rejected. These samples were not utilized in the calculation of the RPD.

Four (4) duplicate samples were submitted to the laboratories for the analysis of uranium isotopes, this frequency meets the requirements of the QAA. However, one of the sample results were validated as rejected for all uranium isotopes analyzed. Overall with 24 plots being sampled, the QAA requires the collection of 2 duplicate samples for a total of 10 analyses (Pu, Am, U-isotopes). Thirteen results were acceptable for a +100% completion percentage.

With 28 plots being sampled, the QAA requires the collection of 2 duplicate samples for a total of 10 analyses. Fifteen results were acceptable for +100% completion percentage.

A total of 2 rinsate samples were required to be collected and analyzed for a total of 10 analyses. One americium result was validated as rejected. Nine results were considered acceptable for this sampling program. Therefore, a total of $\geq$90% of the required rinsate data was completed.

4.3.2 OU-2 PHASE II RFI/RI SURFACE SOIL DATA

4.3.2.1 CDH Sampling Method

The data was downloaded from the RFEDS and was determined to be 98.7 percent validated prior to evaluating for usability according to this procedure. Seventy-five results were validated as rejected and were excluded as usable data.

4.3.2.1.1 Real Samples

The OU2 Work Plan proposed the collection of surface soil samples at 124 plots for radiochemical analyses to include plutonium-239/240, americium-241, uranium-233/234, -235, and -238 for a total of 620 sample results. Validated data was provided for a total of 585 samples for 94% completion overall. The OU2 QAA states that the target completeness objective for both field and analytical data for this project are 90%.

A total of 118 surface soil samples were collected at 118 of the proposed 124 plots for radiochemical analyses to include plutonium-239/240, americium-241, uranium-233/234, -235, and -238.

Results for 140 "real" samples were downloaded from RFEDS for plutonium-239/240, indicating that 22 samples were reanalyzed. Twelve samples exceeded the detection limit of 0.03 pCi/g. However all results of these samples were above the detection limit and are consider acceptable for the determination of spatial extent of contamination. Eleven plutonium-239/240 sample results were validated as rejected results, however, these samples were reanalyzed and results were validated. A plutonium-239/240 value was determined acceptable for each sample collected at all 118 plots (100% complete).

Results for 140 "real" samples for americium-241were provided from RFEDS, indicating that 22 samples were reanalyzed. Fifteen (15) samples exceed the detection limit of 0.02 pCi/g for americium. These sample results were above the detection limits and are considered acceptable. Twelve sample results were validated as rejected results, however 11 of the samples were reanalyzed and results were validated. Sample SS00045WCU2 for Plot PT081 was validated as rejected and was not reanalyzed. Therefore, acceptable results for americium-241 are available for 117 of the 118 plots sampled (99% complete).

Results for 142 "real" samples for uranium-233/234 were provided from RFEDS, indicating that 24 samples were reanalyzed. One samples exceeded the detection limit of 0.3 pCi/g. The result was higher than the detection limit but the result was validated as rejected. A total of 12 uranium-233/234 sample results were validated as rejected, however, eleven were reanalyzed and the results were acceptable. Sample SS00028WCU2 at Plot PT100 was validated as rejected and not reanalyzed. Therefore, acceptable results for uranium-233/234 are available for 117 of the 118 plots sampled (99% complete).

Results for 144 "real" samples for uranium-235 were provided from RFEDS, indicating that 26 samples were reanalyzed. Twelve samples exceed the detection limit of 0.3 pCi/g for uranium-235, however, eleven of these samples were reanalyzed and the results were acceptable. Sample SS00028WCU2 at Plot PT100 was validated as rejected and not reanalyzed. Therefore, acceptable results for uranium-235 are available for 117 of the 118 plots sampled (99% complete).

Results for 144 "real" samples for uranium-238 were provided from RFEDS, indicating that 26

samples were reanalyzed. No samples exceed the detection limit of 0.3 pCi/g. One sample SS00028WCU2 at Plot PT100 was validated as rejected and not reanalyzed. Therefore, acceptable results for uranium-238 are available for 117 of the 118 plots sampled (99% complete).

4.3.2.1.2 QC Samples

General results for precision compliance are discussed in Section 4.1, while rinsate compliance is discussed in Section 4.2. Overall, 77% of the required QA/QC analyses provided acceptable results.

A total of 7 duplicates were collected and analyzed for plutonium-239/240 and americium 241 in support of the CDH sampling program. These samples met the frequency requirements of 1 in 20 as required by the QAA. Of the samples analyzed for plutonium-239/240, no samples exceeded the detection limit of 0.03 pCi/g. Two plutonium-239/240 sample results were validated as rejected results and reanalyzed at a different laboratory with results being validated. The 7 samples were also analyzed for americium, no sample results exceed the detection limit of 0.02 pCi/g. Two sample results were validated as rejected results and reanalyzed with results being acceptable .

Six (6) duplicate samples were submitted to the laboratories for the analysis of uranium isotopes, this frequency meets the requirements of the QAA. However, two of the sample results were validated as rejected for all radionuclides analyzed. These two samples were reanalyzed at a different laboratory with results being validated. With 118 plots being sampled, the QAA requires the collection of 6 duplicate samples for a total of 30 analyses. Twenty-six results were acceptable for a 86% completion percentage.

With 118 plots being sampled, the QAA requires the collection of 6 duplicate samples for a total of 30 analyses. Twenty-six results were acceptable for a 86% completion percentage.

A total of 7 rinsates were collected and analyzed for plutonium-239/240 and americium 241 in support of the CDH sampling program. These samples met the frequency requirements of 1 in 20 for rinsate samples as required by the QAA. Of the samples analyzed for plutonium-239/240, no samples exceeded the detection limit of 0.03 pCi/g or were rejected. Samples analyzed for americium-241 did not exceed the detection limit of 0.02 pCi/g or were rejected.

Only 2 rinsates samples were analyzed for uranium-233/234, -235, and -238. This frequency did not meet the requirements of 1 in 20 for rinsate samples in the QAA. Two analyses for each uranium-isotope was performed All analytical results for the isotopes were validated as rejected for the first analyses. The samples were reanalyzed with results being validated.

Of the 118 plots proposed for sampling 6 rinsate samples are required to be collected. Of the 6 samples determination of plutonium-239/240, americium 241, uranium-233/234, -235, and -238 were to be performed for a total of thirty analyses. Analytical results for rinsate samples were acceptable for 18 samples for a completion of 60 percent.

4.3.2.2 RFP Sampling Method

Data downloaded from the RFEDS were determined to be 80 percent validated prior to evaluating for usability according to this procedure. The Phase II RFI/RI Report states that 118 plots were sampled and analyzed; RFEDS provided data for only 106 plots. Uranium isotopes were not analyzed for samples collected utilizing the RFP sampling method.

4.3.2.2.1 Real Samples

The OU2 RFI/RI does not state the decision driving the investigation. Based on the subsequent documentation the data was generated to compare RFP sampling technique with the CDH sampling technique. Using these assumptions 103 plots provided plutonium-239/240 results which are usable out of 118 plots proposed for sampling in support of this program. Sample results validated as rejected have been excluded. This represents 87% of the plots proposed for sampling (118) provided useful data for the sampling comparison study.
A total of 236 samples were analyzed for this sampling program. Thirty-three results were validated as rejected and are not usable. Therefore, a total of 89% of the data is considered usable. Overall, 83% of the RFP sampling method data proposed to be collected for the comparability study were validated. The OU2 QAA states that the target completeness objective for both field and analytical data for this project are 90%.

Plutonium-239/240 data was available from 106 plots, Plot 28 was resampled, therefore, 107 samples were provided to the laboratory for analysis. A total of 114 plutonium-241 analyses were performed on these samples. Seven samples were reanalyzed. Analyses of 32 plutonium-239/240 samples exceeded the detection limit of 0.03 pCi/g. However, all results of these samples were above the detection limit and are considered usable for the determination of spatial extent of contamination, with the exception of 4 which were validated as rejected. Four plutonium-239/240 sample results, previously mentioned, were validated as rejected results. Data from 103 plots were determined to be validated of the 107 plots in which data was evaluated. However 118 plots were to be evaluated therefore, 87% of proposed plots generated americium-241 data which was validated.

Americium data was available from 106 plots, Plot 28 was resampled, therefore 107 samples were provided to the laboratory for analysis. A total of 174 americium-241 analyses were performed on these samples. It appears that 72 samples were reanalyzed. Thirty-two samples exceed the detection limit of 0.02 pCi/g for americium. Fourteen of these sample results were above the detection limits and are considered usable. Twenty-nine sample results were validated as rejected results. Results for 135 analyses were validated from 92 plots. Numerous plots had multiple americium-241 "real" results because of sample reanalysis or two separate laboratories performing analyses on the same sample. The lower result value was excluded from the database leaving one (the highest) americium-241 value for each plot. Ninety-two plots have americium-241 results of the 107 plots in which data was evaluated. With an original objective of 118 plots, 78% of proposed plots generated usable americium-241 data.

4.3.2.2.2 QC Samples

A total of 11 duplicates were collected and analyzed for plutonium-239/240 and americium 241 in support of the RFP sampling program. These samples met the frequency requirements of 1 in 20 as required by the QAA. Of the samples analyzed for plutonium-239/240, two samples exceeded the detection limit of 0.03 pCi/g. Two samples exceeded the detection limit of 0.02 pCi/g for americium. No results were validated as rejected, therefore, a total of 100% of the duplicate sample result data is considered usable.

A total of 8 rinsates were collected and analyzed for plutonium-239/240 and americium 241 in support of the RFP sampling program's 118 locations. These samples met the frequency requirements of 1 in 20 for rinsate samples as required by the QAA. Of the samples analyzed for plutonium-239/240, no samples exceeded the detection limit of 0.03 pCi/g or were rejected. Samples were collected and analyzed for americium-241, no samples exceeded the detection

limit of 0.02 pCi/g or were rejected.

Of the 118 plots proposed for sampling 6 rinsate samples are required to be collected. Of the 6 samples plutonium-239/240 and americium 241 were planned for a total of twelve analyses. Analytical results for rinsate samples were acceptable for 16 analyses for a completion of 100 percent.

4.3.3 SOIL PROFILE DATA

Data were determined to be 97 percent validated. The Phase II RFI/RI Report states that 26 plots were sampled and analyzed, RFEDS provided data for only 25 plots. Samples from Trench 6 exceeded limitations for transporting to an offsite lab and therefore were not evaluated.

4.3.3.1 Real Samples

Overall, 921 sample results provided acceptable data out of 1,300 proposed (5 analyses x 260 samples) analyses for a 71% completion.

Plutonium-239/240 data was available from 25 trenches with 258 samples. A total of 296 plutonium-239/240 analyses were performed on these samples. Forty samples were reanalyzed. Analyses of 15 plutonium-239/240 samples exceeded the detection limit of 0.03 pCi/g of which 6 of the sample results were validated as rejected. However, results of the remaining samples were above the detection limit and were acceptable. A total of 73 results were validated as rejected. Plutonium-239/240 data from 224 samples were determined to be validated at 24 of the 26 trenches in which data was evaluated. Based on 10 samples proposed at each of the 26 trenches, 86% (224/260) of the plutonium-239/240 data was validated and useable.

Americium-241 data was available from 25 plots with 257 samples. A total of 301 americium-241 analyses were performed on these samples. Approximately 44 samples were reanalyzed. Forty-two samples exceeded the detection limit of 0.02 pCi/g for americium and 38 of these were rejected, leaving four results above detection limits and considered usable. A total of one-hundred- nine americium samples results were validated as rejected. Results for 184 analyses were validated from 21 trenches. Seventy-one percent (184/260) of the americium data was evaluated as acceptable.

Uranium-233/234 data was available from 25 plots with 258 samples. A total of 268 uranium-233/234 analyses were performed on these samples. Approximately 10 samples were reanalyzed. Eighteen samples exceeded the detection limit of 0.3 pCi/g of which all these results were rejected. A total of ninety uranium-233/234 samples results were validated as rejected. Results for 171 analyses were validated from 17 trenches. Sixty-six percent (171/260) of the uranium-233/234 data was evaluated as acceptable.

Uranium-235 data was available from 25 plots with 258 samples. A total of 268 uranium-235 analyses were performed on these samples. Approximately 10 samples were reanalyzed. Four samples exceeded the detection limit of 0.3 pCi/g of which all these results were rejected. A total of ninety-five uranium-235 samples results were validated as rejected. Results for 171 analyses were validated from 17 trenches. Sixty-six percent (171/260) of the uranium-235 data was evaluated as acceptable.

Uranium-238 data was available from 25 plots with 258 samples. A total of 268 uranium-238 analyses were performed on these samples. Approximately 10 samples were reanalyzed. Thirteen samples exceeded the detection limit of 0.3 pCi/g of which all these results were

rejected. A total of ninety-seven uranium-238 samples results were validated as rejected. Results for 171 analyses were validated from 17 trenches. Sixty-six percent (171/260) of the uranium-238 data was evaluated as acceptable.

4.3.3.2 QC Samples

Based on the number of samples collected (268) to meet the one in twenty frequency, fourteen samples should have been collected for each analytical method. Five analyses were to be performed on each duplicate for a total of 70 analyses. The evaluation indicates that results from 41 analyses provided acceptable results for 59% (41/70) completion factor.

Ten duplicate samples were collected in support of the trench project. These samples did not met the frequency requirements of 1 in 20 as required by the QAA. Eleven analyses were performed for plutonium-239/240. Of the samples analyzed for plutonium-239/240, no analyses exceeded the detection limit of 0.03 pCi/g. Two plutonium-239/240 QA/QC sample results were validated as rejected results, one sample was reanalyzed and the results were validated. Nine samples provided acceptable results.

Twelve analyses were performed for americium-241, two samples exceeded the detection limit of 0.02 pCi/g and were validated as rejected. A total of 4 sample results were validated as rejected, one sample was reanalyzed with acceptable results. Eight samples provided acceptable results.

Eleven analyses were performed for uranium-233/234, no samples exceeded the detection limit of 0.3 pCi/g. A total of 3 sample results were validated as rejected, one sample was reanalyzed with acceptable results. Eight samples provided acceptable results.

Eleven analyses were performed for uranium-235, one sample exceeded the detection limit of 0.3 pCi/g and was validated as rejected. A total of 3 sample results were validated as rejected. Eight samples provided acceptable results.

Eleven analyses were performed for uranium-238, no samples exceeded the detection limit of 0.3 pCi/g. A total of 3 sample results were validated as rejected. Eight samples provided acceptable results.

Overall, 75 rinsate analyses provided acceptable results, 14 samples and 70 analyses were required to meet the 1 in 20 frequency. Rinsate results were 100% complete.

A total of 23 rinsates were collected and analyzed for plutonium-239/240, americium 241 and uranium isotopes in support of the trench sampling program. These samples met the frequency requirements of 1 in 20 for rinsate samples as required by the QAA. Of the samples analyzed for plutonium-239/240, four samples exceeded the detection limit of 0.03 pCi/g, of which two were validated as rejected. A total of three samples results were validated as rejected. One sample result which was not validated had a result lower than the detection limit and was excluded from the evaluation. Analyses of nineteen samples provided acceptable results

Samples were collected and analyzed for americium-241; nine samples exceed the detection limit of 0.02 pCi/g of which three were validated as rejected. These were the only sample results validated as rejected. Analyses of twenty samples provided acceptable results for americium-241.

Twenty-three samples were collected and twenty-five analyses were performed for uranium-235. Three samples exceeded the detection limit of 0.3 pCi/g of which none were validated as rejected. A total of six results were validated as rejected, providing nineteen sample results which were acceptable.

Samples were collected and analyzed were for uranium-238, three samples exceed the detection limit of 0.3 pCi/g of which none were validated as rejected. A total of six results were validated as rejected, providing seventeen sample results which were acceptable.

4.4 REPRESENTATIVENESS

In general, samples are representative of the media requested in the original work plans, based on work plan compliance and compliance with required sampling protocols (i.e., standard operating procedures {SOPs}). Adherence to procedures was verified by several QA surveillances in the field.

4.4.1 OU-1 PHASE III RFI/RI SURFICIAL SOIL DATA

Twenty-eighth plots were identified in TM5 for sampling. A total of 34 samples were collected from 28 plots for a total of 100% of the locations being sampled.

Representativeness of OU1 Phase III Sampling Results

	Required Number of Samples per Sampling Plan Specifications	Actual Number of Samples Collected	Deviation From Work Plan	Justification
Radionuclides	28 Plots	34	+6	Plots RA011, RA015, RA031, RA032, RA033, and RA037 were sampled twice.

4.4.2 OU-2 PHASE II RFI/RI DATA

One hundred-twenty four plots were identified in the OU2 Work Plan for sampling. A total of 118 plots were sampled utilizing the CDH method for a total of 95% of the locations being sampled.

RFP samples were collected at each plot a CDH sample was collected for a total of 118 samples. Only data from 106 plots were obtained from RFEDs. The analytical results from the remaining 12 plots could not be located in RFEDS.

Representativeness of CDH Sampling Method Results

	Required Number of Samples per Sampling Plan Specifications	Actual Number of Samples Collected	Deviation From Work Plan	Justification
Radionuclides	124	118	-6	Plots 2, 8, and 9 were not sampled because they were in areas covered with asphalt. Plots 7, 14, 27, and 18 were not sampled because they are located in the PA fence and soils are highly disturbed.

	Required Number of Samples per Sampling Plan Specifications	Actual Number of Samples Collected	Deviation From Work Plan	Justification
				Plot 0 added to sampling program following implementation of field program.

One hundred-eighteen plots were sampled by CDH methods and were to be sampled by RFP methods. Data for 106 plots were located and evaluated for a total of 90% of the plots being evaluated.

Soil samples were collected at each of the 26 trenches. Samples collected from Trench 6 exceed DOT shipping restrictions and were not analyzed.

Representativeness of RFP Sampling Method Results

	Required Number of Plots sampled per Sampling Plan Specifications*	Actual Number of Plots Sampled	Deviation From Work Plan	Justification
Radionuclides	118	106	-12	OU2 Phase II RFI/RI Report states RFP samples were collected at all locations CDH samples were collected. Only results from 106 plots could be located for this evaluation

* The collection of RFP method samples were not included in the OU2 Work Plan.

4.4.3 SOIL PROFILE DATA

Representativeness of OU2 Phase II Trench Results

	Required Number of Plots sampled per Sampling Plan Specifications*	Actual Number of Plots Sampled	Deviation From Work Plan	Justification
Radionuclides	26	25	-1	OU2 Phase II RFI/RI Report states Trench samples were collected at all locations. However, Trench 6 samples exceed DOT shipping restrictions and could not be sent off site for analyses.

4.5 COMPARABILITY

Based on radiochemical methods used and cited, radiochemical values of the samples between the projects are comparable. However, the areal extent that is represented by each sample result may not be comparable, and must be evaluated on a location-by-location basis relative to the remediation area and "working" soil-volumes of interest.

5.0 CONCLUSIONS

Although several DQOs specific to the original work plans were not met with respect to several of the PARCC parameters, fundamental quality controls on the radiochemistry data were adequate to allow use of the data within the context of their representative three-dimensional locations, and with respect to current RFCA action levels (Tier I or II).

The OU1 Phase II surface soil program employed systematic composite sampling techniques at the center of a randomly selected 50 x 100 feet plots. This method involved the collection of 10 grab samples and mixing them together and analyzing a subsample for the composite. A physical averaging process took place so that subsamples represent the average concentration of the original grab samples. Therefore, the sample results represents some average activity over the area sampled. The sample results do not measure variability of extreme concentrations (e.g., hot spots).

The CDH sampling method employed systematic composite sampling techniques over entire plots sampled on either 2.5 or 10 acre areas. These methods involved the collection of 25 grab subsamples and mixing them together and analyzing a portion the composite. A physical averaging process took place so that subsamples represent some average concentration of the original grab samples. Therefore, sample results represent some average activity over the sampled plot. The sample results do not measure variability of extreme concentrations over the subsampled area.

The RFP sampling method employed systematic composite sampling techniques at the center of each plot previously sampled by the CDH sampling method. This method involved the collection of 10 grab samples from two separate square meter areas separated by one square meter. The grab subsamples were mixed together and a portion was collected for the composite sample finally analyzed. A physical averaging process took place so that a physical average concentration of the original grab samples was measured. Therefore, the sample results only represent an average activity over the sampled area.

The OU2 Trench sampling method employed composite sampling techniques at several depths within a trench. This method involved the collection of 3 grab samples from the same depth of the trench. The grab samples were mixed together and a subsample was collected for the composite. A physical averaging process takes place so the subsamples represent the average concentration of the original grab samples. Therefore, the sample results represents an average activity over the sampled depth, at the specific trench location.

Samples were collected at all 26 trench locations and analyses from 25 locations were provided by RFEDS. Samples collected from trench 6 were not analyzed because sample activity exceeded routine DOT shipping requirements. The analyses of samples provided an adequate number of acceptable data for $\geq$ 90% completion. The data were of sufficient quality to meet completion requirements of the OU1 Phase III RFI/RI DQOs.

REFERENCES

DOE/EG&G Rocky Flats, 1994. General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Part B, Radioanalytical Services Protocol (RASP), Statement of Work, Version 3.0

DOE, 1992. Draft Final Technical Memorandum 5, Addendum to Final Phase III RFI/RI Work Plan, Surface Soil Sampling and Analysis Plan, Rocky Flats Plant 881 Hillside Area (Operable Unit No. 1)

DOE, 1991. Quality Assurance Addendum QAA 2.1 to the Rocky Flats Plant Site-Wide QA Project Plan for CERCLA RI/FS and RFI/CMS Activities for Operable Unit No. 2 (Alluvial), 903 Pad, Mound and East Trenches Areas, Phase II RFI/RI

Luker, R.S., Stagg, D., and M. C. Brooks, (1995). "Environmental Data Problems and Potential Liabilities: A Case Study of "Technical Integrity" vs. "Legal Defensibility", SUPERFUND XV Conference and Exhibition, Washington, DC, November, 1995

903 DRUM STORAGE SITE, 903 LIP AREA,

AND

NON-IHSS AREA DATA SUMMARY

APPENDIX C

Data Source: EPA

Title: 903 OIL STORAGE AREA

Keywords:

Comments:

Authors: FREIBERG K J

Pub_Date1: 04/14/1970

Pub_Date2:

Date Estimated?: N

Document Type: INTERNAL LETTERS

Addressee: PUTZIER E A

Distribution:

Document Size:

Doc. Location: RECORDS MANAGEMENT / LITIGATION SUPPORT

Reference No.: REF #: 2000595; VOLUME: 502; SUBPOENA #:

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2000595-00006581-502
APPENDEX B-34
2000595

THE DOW CHEMICAL COMPANY

ROCKY FLATS DIVISION
P. O. BOX 888
GOLDEN, COLORADO 80401

April 14, 1970

E. A. Putzier

903 OIL DRUM STORAGE AREA

A brief history of the disposal of oil drums from the 903 Area is described below:

1. Work to remove oil from the 903 Area began January 23, 1967, under the supervision of O. M. Anderson, H. E. Maas, and R. M. Vogel.

2. From January 23, 1967, through March 10, 1967, uranium oil drums which were in good condition were transferred to Building 774 and processed.

3. Building 903 went hot on March 10, 1967, and started processing oil drums. This building was designed to prefilter the oil prior to transferring plutonium contaminated oil to Building 774 for final processing.

4. From March 10, 1967, through May 18, 1967, there were a total of 191 drums of plutonium contaminated oil filtered and shipped to Building 774.

5. On May 18, 1967, operations at Building 903 were discontinued due to the amount of time this process was taking.

6. Drum-to-drum transfer in the field began May 18, 1967, and the drums shipped to Building 774 without prior filtration in Building 903.

7. From March 17, 1967, through May 10, 1967, in addition to the plutonium transfers there were 297 drums of uranium contaminated Alk-Tri waste shipped to Building 774 and processed.

8. May 10, 1967, through May 28, 1968, a total of 4,826 drums containing 50 gallons of oil each were sent to Building 774 and processed.

9. In addition to the oil storage area drums, there were a total of 650 drums from Building 776 current generation sent to Building 774 for processing. A pipe line installed

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[redacted]

ATOMIC ENERGY COMMISSION CONTRACT AT(29-1)-1106

911P221 B 9001133163
EPA APRIL 23 1992 ITEM 12 24 E 4173

from Building 776 to Building 774 eliminated this additional oil drum generation.

10. During the transfer operations, it was noted that at the bottom of all drums a deposit of sludge remained after removal of the oil. This sludge varied in depth from 1/2 inch to 3 inches and averaged approximately 1 inch. By drum counter results the sludge within the empty drums contained a total of 5,152 grams of plutonium. These empty drums were later disposed of by adding Oil Dry and MicroCel to absorb the sludge. The drums containing the plutonium sludge and absorbent were then incased in plastic, placed in boxes, and shipped to the burial grounds.

11. The total number of drums originally in the field numbered 5,237. After transfer of contents, 4,826 drums were transported to Building 774 of which 3,572 contained plutonium contaminated oil.

12. Taking the total number of 5,237 drums minus 4,826 drums, containing 50 gallons each, which were sent to Building 774 leaves 411 drums to be accounted for. The best explanation for the 411 drums and the volume contained within each follows:

    A. All of the drums sent to the oil storage field originally were not completely full.

    B. Volume taken up by the sludge which was discarded with the empty barrels.

    C. Leakage out of the barrels and into the ground within the storage area.

13. To the best of everyone's memory and knowledge, a total of approximately 100 barrels containing 50 gallons each or 5,000 gallons of oil leaked out of the drums and was absorbed into the soil within the fenced area.

14. The average of all oil samples taken from the plutonium contaminated oil barrels was approximately 5×10^{-3} grams of plutonium per liter of oil. This number is backed up by the letter from M. E. Maas dated September 24, 1968, that shows a total of 3,065 grams of plutonium which was accounted for during the process of the contaminated oil.

[redacted]

There were 594 grams salvaged from filters out of Building 903 and accounted for from organic liquid solidification processing in Building 774 were 2,471 grams totaling 3,065 grams. Therefore, taking the 3,572 drums of plutonium which were processed at 50 gallons each we get a total of 178,600 gallons or 675,108 liters of oil. Divide this number of 675,108 liters into 3,065 grams and we get 4.54×10^{-3} grams per liter.

15. Using 4.54×10^{-3} grams per liter in conjunction with the estimated 5,000 gallons of oil that remains under the asphalt we will get (5,000 gallons or 18,900 liters x 4.54×10^{-3} grams per liter) = 85.81 grams of plutonium (This is the amount of plutonium remaining under the asphalt pad.).

16. May 28, 1968, through June 11, 1968, the remaining empty drums and wooden pallets were placed into waste boxes and shipped.

17. In July, 1968, a survey of the plutonium contamination on the surface of the soil in the 903 Area was completed. The results of the survey and the Health Physics recommendation for containment of the contamination were sent to Division Services, Manufacturing and Facilities.

18. In October, 1968, weeds and vegetation were burned off the 903 contaminated barrel storage area preparatory to applying an asphalt cap over the area. No airborne contamination problems were encountered.

19. In November, 1968, grading outside the hot fence area was started in preparation to applying an asphalt cap over the area. This work consisted of moving slightly contaminated soil to the fenced area.

20. In late November, 1968, the six contaminated holding tanks outside Building 903 were disconnected and crated for shipment to hot waste.

21. On December 17, 1968, E. Mathews, USAEC ALO Operational Safety Division, visited Rocky Flats. The purpose of his visit was to discuss the history and corrective actions for the 903 Area. He also indicated an interest in the drum storage area east of the nitrate ponds.

[redacted]

22. On January 15, 1969, the hot fence was ...ced into two hot waste boxes and shipped.

23. On February 15, 1969, three more waste boxes were shipped from the 903 Area containing Type 5 LASA waste.

24. The two fork lifts which were highly contaminated during the oil drum removal were placed into wooden crates and shipped to hot waste on April 1, 1969.

25. During May, 1969, a total of 33 drums of contaminated rocks were removed from the 903 Area and discarded as hot waste.

26. In May, 1969, Building 904 was decontaminated and removed to a location east of the Fire Barn to accomodate drybox flammability studies.

27. In May, 1969, the road grader used to move contaminated soil and rocks outside of the 903 fenced area was decontaminated and released to surplus.

28. In July, 1969, Building 903 was moved to a location immediately east of Building 666.

29. On July 23, 1969, the first course of fill was applied to the 903 Area.

30. The base course material overlay, the soil sterilant, and the asphalt prime coat for the 903 contamination barrier were completed on September 24, 1969.

31. During October, 1969, the asphalt was applied. The four sample wells around the 903 Area were completed on November 11, 1969.

32. Starting February 23, 1970, operations were started to apply additional fill over the surrounding area directly east of 903 due to soil contamination.

33. Additional soil fill operations were completed on March 4, 1970.

34. As of April 3, 1970, no water has been detected in the wells.

K. J. Freiberg
Health Physics

KJF:sls

[redacted]

2085300
751100

2089400
751100

N

EAST SPRAY FIELDS – CENTER

NORTHEAST TRENCHES AREA

S. VALMUT CREEK

B-1
B-2
B-3
B-4

216.2

216.3
EAST SPRAY FIELDS – SOUTH

110
111.1
111.7
111.8
111.2
111.3
111.6
111.4
111.5

OIL BURN PIT NO. 2

113

PALETTE BURN SITE

154
153
108

112
155
183

903 LIP AREA

109
140

REACTIVE METAL DESTRUCTION SITE

SOUTHEAST TRENCHES AREA

2085300
748200

2089400
748200

LEGEND

- Streams
- Paved Roads
- Buildings
- Fence
- New IHSS Boundary
- 216.3 IHSS Identification Number

0 250 500 FEET

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ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Figure 2-2

903 Drum Storage Site Data Summary IHSS Location Map

95DN1352, 09/18/95 at 13:00

Figure 3-5

AM-241 Activity in Surface Soils 1990 In Situ HPGe Survey

EXPLANATION

Am Isoconcentraiton Contours (pCi/g)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95
HPGe - In situ Surveys of the USDOE's Rocky Flats Plant Golden, Co EGG-10617-1123 May 1991

Scale = 1 : 3720
1 inch represents 310 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

RMRS **Rocky Mountain Remediation Services, L.L.C.**
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

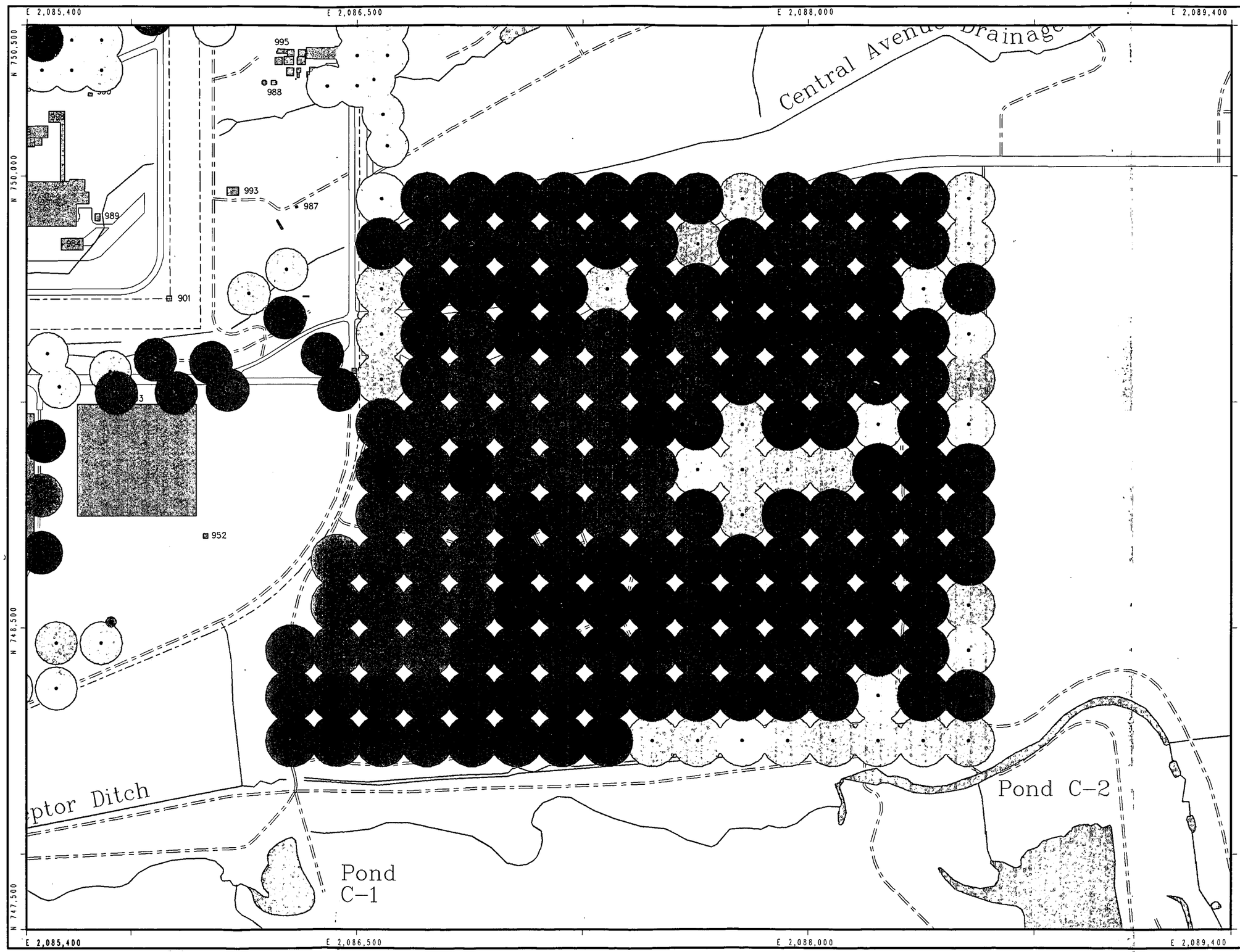
MAP ID: 97-0109

August 27, 1997

/gis/projects/97-0109/am.aml

Figure 3-6

HPGe Data for Am-241 pCi/g (for a Field of View of 150 feet)



HPGe Data Ranges--

- 0.0 - 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10000

Standard Map Features--

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

NOTE:
Raw field data which has not been evaluated and may be influenced by building shine.

The HPGe field of view (FOV) or radius of influence, assumes a homogeneous surface distribution. The FOV represents a circle where 90% of the flux originates. The radius, for each HPGe sampling location, is based on the height of the detector above the ground.

The FOV for the majority of the points is 150 feet; however, two of the survey locations have a FOV of less than 150 feet.

DATA SOURCE:
HPGe data from Ron Reimer, Gamma Survey Group, Safeguard Measurements, EG&G Rocky Flats, Inc. June 1994
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/96

150 0 300ft

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P.O. Box 464
Golden, CO 80402-0464

MAP ID: HPGe-OU2 August 28, 1997

Figure 3-9

OU2 Phase II RFI/RI
Surface Soil Sampling Sites
Radiological Results
CDH Sampling Method

EXPLANATION

- Surface Soil Plots
- Location Exceeding Tier I Actions Levels

LOCATION = PT094
SUM OF RATIO = 0.0233

NS - NOT SAMPLED

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G R3L, Las Vegas.
Digitized from the orthophotographs. 1/95

100 0 200 400ft

State Plane Coordinate Projection
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August 27, 1997

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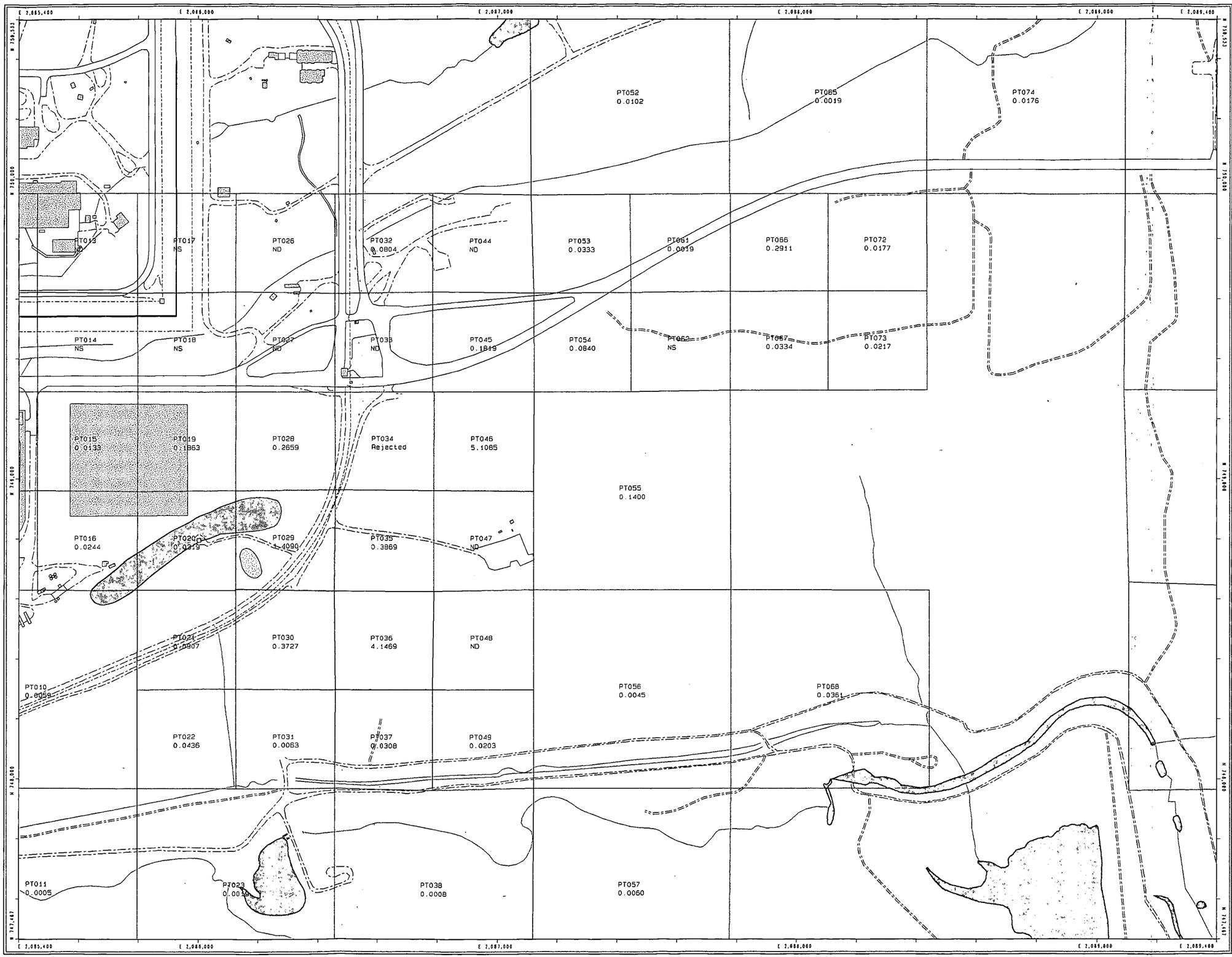

Figure 3-10

OU2 Phase II RFI/RI Surface Soil Sampling Sites Radiological Results RFP Sampling Method

EXPLANATION

- Surface Soil Plots
- 1976 Soil Removal Area (approx)
- 1978 Soil Removal Area (approx)
- Location Exceeding Tier I Actions Levels

LOCATION = PT001
SUM OF RATIO = 0.0002

NS - NOT SAMPLED
ND - NO DATA

Standard Map Features

- Buildings & other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 97-0039 August 27, 1997

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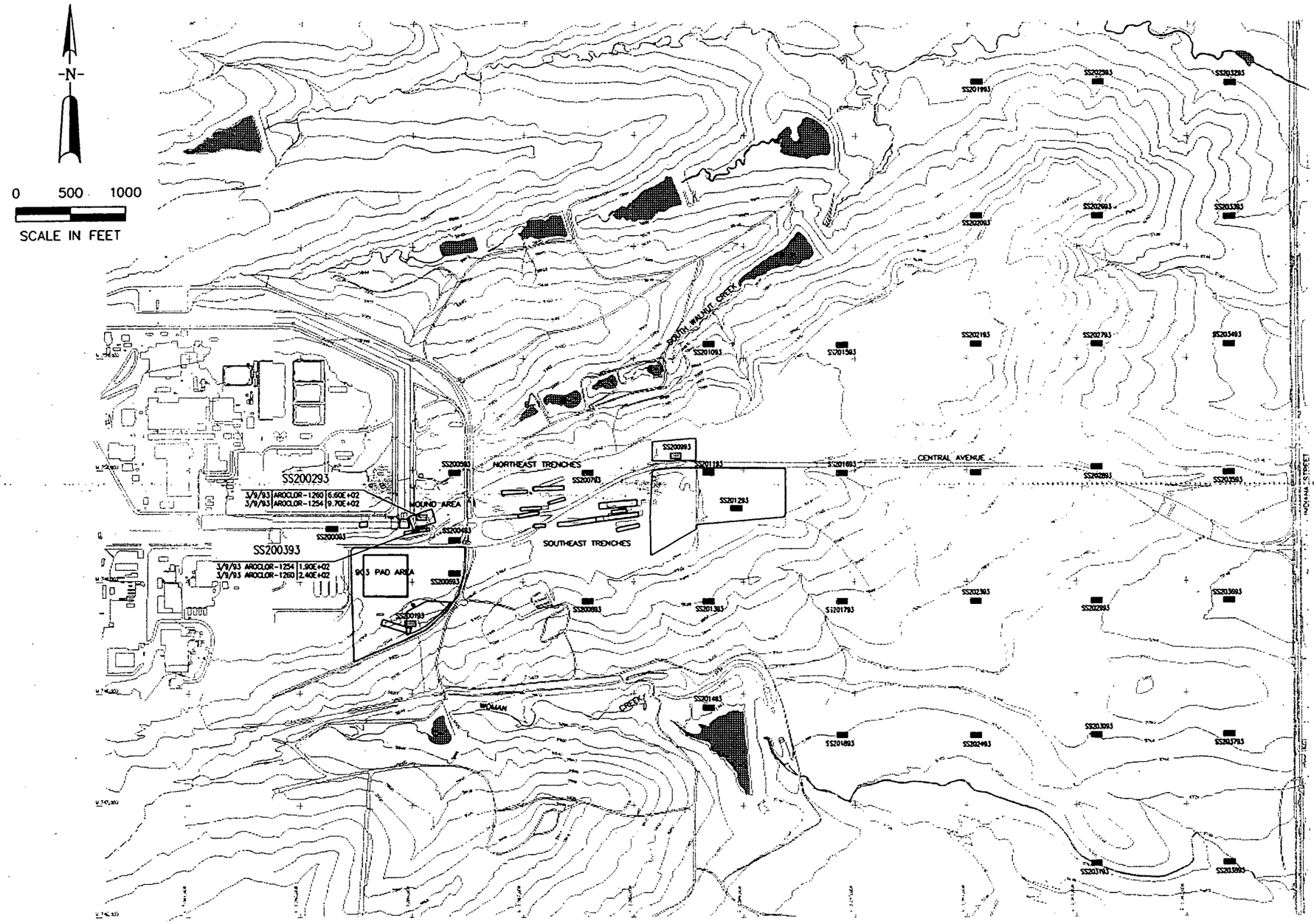

EXPLANATION

SS200193 — BIASED SURFACE SOIL SAMPLING PLOT LOCATION 50'x100' PLOT (1993 RFP SAMPLING)

SS200093 — GRID-BASED SURFACE SOIL SAMPLING PLOT LOCATION 50'x100' PLOT (1993 RFP SAMPLING)

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Golden, Colorado

Figure 3-11

903 Drum Storage Site Data Summary
OU2 Phase II RFI/RI Data
Surface Soil Sampling Locations
Modified RFP Sampling Method

OU2RI866 1=1000

Soil Profile TR08 Results

Depth (cm)	Analyte	Result	Unit	Ratio	Sum of Ratios
0-3	AM-241	1033	PCi/G	4.8047?	
	PU239/40	4208	PCi/G	2.9433?	
	U-233,-234	5.814	PCi/G	0.0033?	
	U-235	2.103	PCi/G	0.0156?	
	U-238	10.21	PCi/G	0.0174	7.7843
3-6	AM-241	544.2	PCi/G	2.5312?	
	PU239/40	1075	PCi/G	0.7523?	
	U-233,-234	2.827	PCi/G	0.0016	
	U-235	0.0765	PCi/G	0.0006?	
	U-238	5.357	PCi/G	0.0091	3.2948
6-9	AM-241	542.5	PCi/G	2.5233	
	PU239/40	1011	PCi/G	0.7075	
	U-233,-234	4.455	PCi/G	0.0026	
	U-235	1.185	PCi/G	0.0086?	
	U-238	6.988	PCi/G	0.0119	3.254
9-12	AM-241	1137	PCi/G	5.2884	
	PU239/40	3356	PCi/G	2.3485	
	U-233,-234	6.796	PCi/G	0.0039	
	U-235	1.768	PCi/G	0.0131?	
	U-238	10.65	PCi/G	0.018	7.6719
15-21	AM-241	294.8	PCi/G	1.3712	
	PU239/40	637.9	PCi/G	0.6563	
	U-233,-234	5.167	PCi/G	0.003	
	U-235	1.023	PCi/G	0.0076?	
	U-238	11.94	PCi/G	0.0204	2.0584
21-27	AM-241	236.4	PCi/G	1.0949	
	PU239/40	1593	PCi/G	1.1148	
	U-233,-234	4.157	PCi/G	0.0024	
	U-235	0.6916	PCi/G	0.0051?	
	U-238	8.27	PCi/G	0.0153	2.2325
33-39	AM-241	45.2	PCi/G	0.2102	
	PU239/40	257.2	PCi/G	0.18	
	U-233,-234	3.159	PCi/G	0.0018	
	U-235	0.3631	PCi/G	0.0027?	
	U-238	10.05	PCi/G	0.0172	0.4119
45-51	AM-241	1.452	PCi/G	0.0068	
	PU239/40	11.72	PCi/G	0.0082	
	U-233,-234	0.6478	PCi/G	0.0004	
	U-235	0.0232	PCi/G	0.0002?	
	U-238	0.6014	PCi/G	0.001	0.0165
69-75	AM-241	0.0276	PCi/G	0.0001	
	PU239/40	0.1871	PCi/G	0.0001	
	U-233,-234	0.4644	PCi/G	0.0003	
	U-235	0.0111	PCi/G	0.0001?	
	U-238	0.3869	PCi/G	0.0007	0.0013
93-99	AM-241	0.8106	PCi/G	0.0038	
	PU239/40	5.997	PCi/G	0.0042	
	U-233,-234	0.7068	PCi/G	0.0004	
	U-235	0.0608	PCi/G	0.0004?	
	U-238	0.6359	PCi/G	0.0011	0.0099

E 2,081,640 E 2,084,000 E 2,088,000 E 2,092,000 E 2,094,121

N 752,000 N 748,000 N 744,000 N 743,179

TR01 TR02 TR03 TR04 TR05 TR06 TR07 TR08 TR09 TR10 TR11 TR12 TR13 TR14 TR15 TR16 TR17 TR18 TR19 TR20 TR21 TR22 TR23 TR24 TR25 TR26

Figure 3-12

OU2 Phase II RFI/RI
Soil Profiles Sampling Sites
Radiological Results
Above Tier I Action Levels

EXPLANATION

- Soil Profile Sampling Sites
- Surface Soil Plots
- 1976 Soil Removal Area (approx)
- 1978 Soil Removal Area (approx)

Standard Map Features

- Buildings & other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSI, Las Vegas.
Digitized from the orthophotographs. 1/95

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 97-0039 August 27, 1997

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N 749,431 N 749,000 N 748,000 N 747,855

903 PAD

RA030 0.0044
RA031 0.0111
RA025 0.0214
RA024 0.0197
RA029 0.0068
RA047 0.0027
RA041 0.0034
RA016 0.003
RA013 0.0035
RA032 0.0042
RA034 0.0068
RA018 0.0075
RA022 0.0067
RA023 0.0144
RA035 0.0044
RA033 0.0063
RA019 0.0052
RA027 0.0128
RA036 0.0022
RA014 0.003
RA037 0.0035
RA020 0.0043
RA010 0.006
RA026 0.0044
RA021 0.0045
RA012 0.003
RA028 0.0035
RA015 0.0046

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

Figure 3-13

OU1 Phase III RFI/RI Surface Soil Sampling Locations RFP Sampling Method

EXPLANATION

- 5 Foot contours
- 903 Pad Lip Area
- 1976 Soil Removal Area (approx)
- 1978 Soil Removal Area (approx)
- LOCATION SUM OF RATIO

Standard Map Features

- Buildings & other structures
- Fences and other barriers
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
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MAP ID: 97-0039 August 29, 1997

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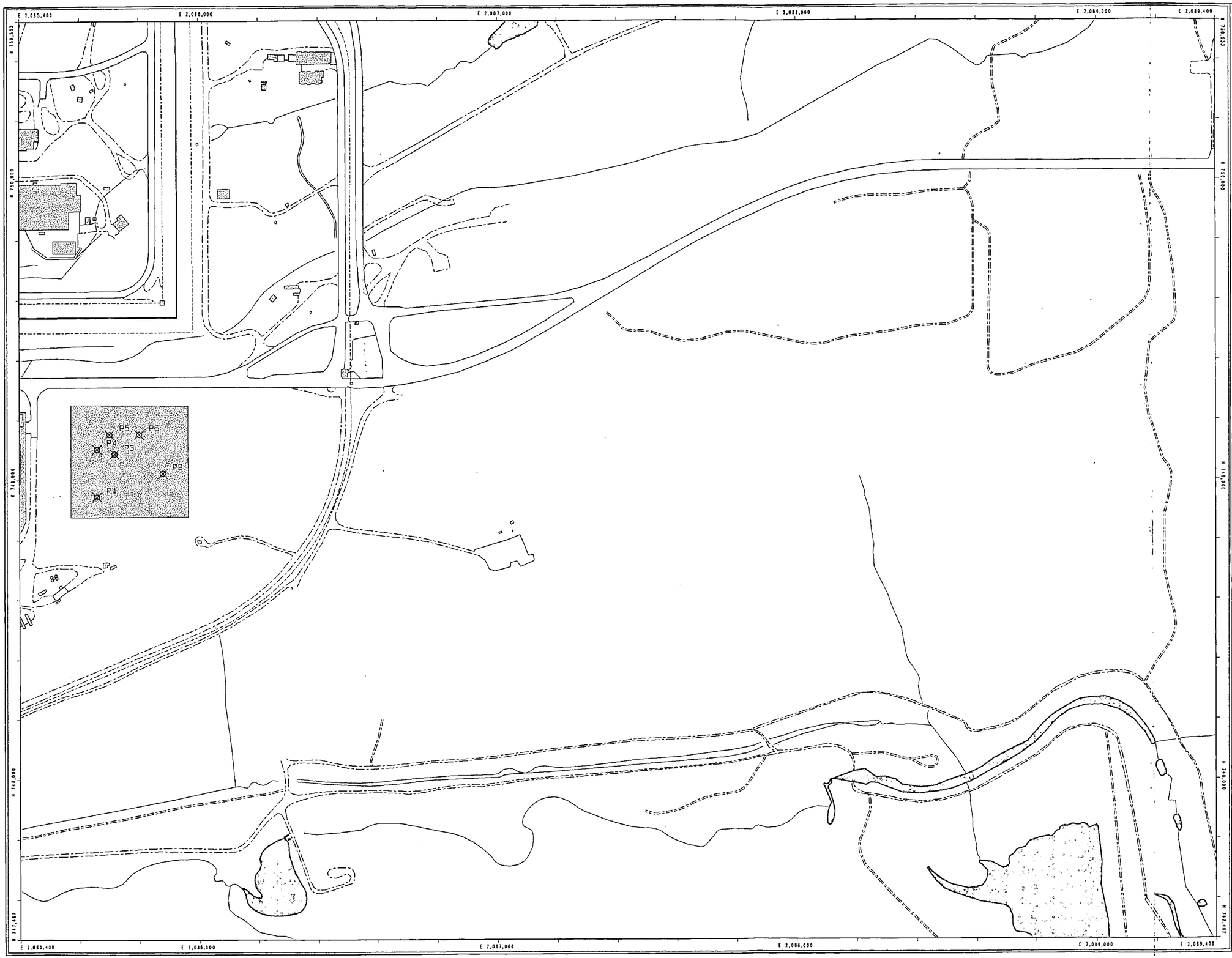

Figure 3-14

Selected Surface Soil Sampling Locations

EXPLANATION

Surface Soil Sample Location

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95

N

Scale = 1 : 3720
1 inch represents 310 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Golden, CO 80402-0464

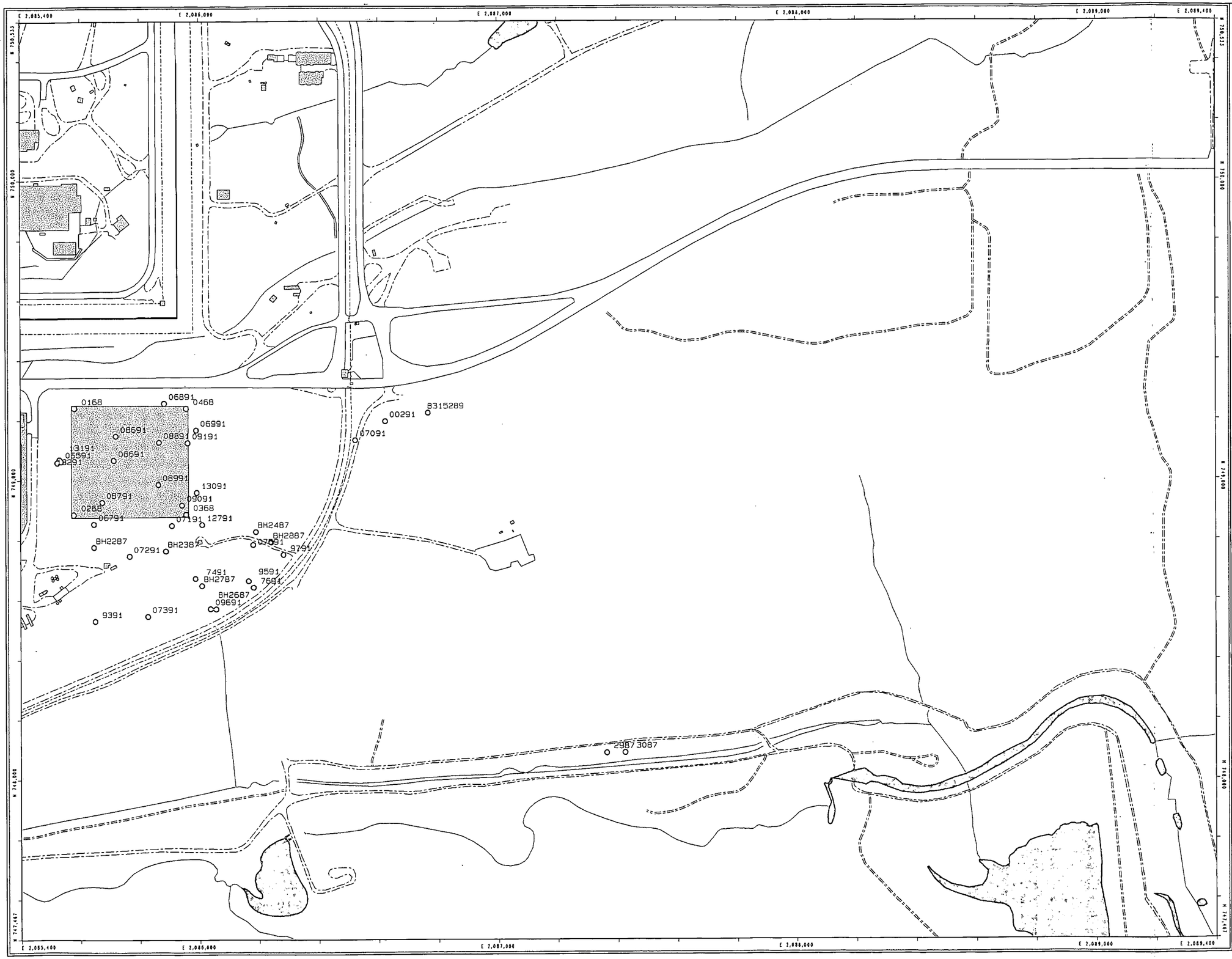
MAP ID: 97-0120

August 27, 1997

/gis2/projects/hye97/97-0120/surfsoil.aml

Figure 3-15

Selected Subsurface and Groundwater Sampling Locations



EXPLANATION

- Groundwater Monitoring Well
- Borehole

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSI, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 3720
1 inch represents 310 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
RMRS Rocky Mountain Remediation Services, L.L.C.
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P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0120 August 27, 1997

[gis]projects\fy97\97-0120\well_bore.aml

DATE: February 11, 1994 | FILENAME: /arc/data/soilvapor/ihss112/svs2352.cmt | REVISION NO: 2

DRAWN BY: DDJ/KJS

APPROVED BY:

CHECKED BY:

IHSS 172

IHSS 155

IHSS 112

IHSS 183

IHSS 140

0168 0468 06891 06991 13191 06591 13291 13091 0268 06791 09091 0368 08891 07191

112-1 43.0; 112-2 121; 112-3 0.0; 112-4 23.0; 112-5 100; 112-6 37.0; 112-7 87.0; 112-8 120; 112-9 23.0; 112-10 8.0; 112-11 6.0; 112-12 77.0; 112-13 332; 112-14 75.0; 112-15 10.0; 112-16 0.0; 112-17 10.0; 112-18 90.0; 112-19 113; 112-20 392; 112-21 478; 112-22 52.0; 112-23 4.0; 112-24 30.0; 112-25 297; 112-26 9.0; 112-27 0.0; 112-28 5.0; 112-29 0.0; 112-30 28.0; 112-31 0.0; 112-32 42.0; 112-33 8.0; 112-34 11.0; 112-35 0.0; 112-36 36.0; 112-37 50.0; 112-38 14.0; 112-39 0.0; 112-40 74.0; 112-41 58.0; 112-42 50.6; 112-43 0.0; 112-44 0.0; 112-45 0.0; 112-46 0.0; 112-47 0.0; 112-48 0.0; 112-49 0.0; 112-50 0.0; 112-51 0.0; 112-52 0.0; 112-53 0.0; 112-54 0.0; 112-55 0.0; 112-56 0.0; 112-57 0.0; 112-58 0.0; 112-59 0.0; 112-60 27081; 112-61 0.0; 112-62 0.0; 112-63 0.0; 112-64 0.0; 112-65 12.1; 112-66 55.5; 112-67 2.2; 112-68 164; 112-69 97.0; 112-70 23.7; 112-71 32.9; 112-72 3.7

Soil Vapor Survey Sampling Locations
TOTAL VOCs, (ug/L)

112-1 0.0 + 5 Foot Sample Depth

112-72 0.0 ⊗ 10 Foot Sample Depth

Boreholes

Soil Vapor Survey Work Plan

IHSS 112 Border

Adjacent IHSS Borders

Fence

CONTOUR INTERVAL

5000 ug/L

50 ug/L

NOTE: Analyte values from the 10 foot depth were not used in the generation of the contours.

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

25 0 25 50 FEET

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO

Figure 3-16

903 Drum Storage Site Data Summary
OU2 Phase II RFI/RI Data
Soil Gas Survey Results

Figure 3-17

Previous Soil Remediation Areas

EXPLANATION

- 5 ft elevation contour
- 1976 Soil Removal Area (approx)
- 1978 Soil Removal Area (approx)
- 1970 Soil Fill Area

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
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100 0 200 400ft

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MAP ID: 97-0109 August 27, 1997

/gis/projects/hyd/97-0109/soilsm.aml